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RADIOGRAPHY OF THE GALL BLADDER

by

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(Figs 6 to 25 on Tabulae XVII—XXI)

So much attention has been directed within recent years to the radiography of the gall bladder region that further discussion would seem to be superfluous. The subjects discussed in the following paper are probably well known to radiologists of experience, yet until quite recently the writer failed to grasp the significance of several of the points which are dealt with. It is in the hope that these new points may be of value to radiologists in general that the paper is presented, and that by calling attention to the probability of improvements in technique leading to a larger percentage of successful diagnoses beginners may be encouraged to try, in all suspected cases, to demonstrate the presence of stone.

Surgeons in particular will appreciate the value of a positive diagnosis of gall stones prior to operation. The knowledge that he has to deal with a gall stone instead of a kidney stone is of great value in a hitherto doubtful case. The number of cases operated upon on an incorrect diagnosis will necessarily diminish when the profession generally realises that a careful X ray examination of the region will reveal the nature of the case.

The first consideration from the radiologist's point of view is naturally that of technique. It is not our intention to deal with this in detail, since the routine technique is well known, and several modifications of it will be referred to briefly. The preparation of the patient is of some importance. Most radiologists have already

a routine practice in this part of the technique, and no special object will be served by the suggestion of variations.

It is of importance to have the bowels well cleared, and, if possible, the activity at the time of examination should not be accelerated by the use of purgatives just immediately before the examination. A twelve hours' interval should be allowed for the stomach and bowel to settle down after a thorough clearing out by purgation. The stomach should not be overdistended. If food is allowed at all, it should be given at such a time as will ensure that the stomach is not actively passing digested food through the pylorus into the duodenum. An actively contracting duodenum will cause movements in the region of the gall bladder, which may spoil the diagnostic value of the examination, if a long exposure is given. These points are dealt with later. Nor is it wise to have the patient fasting. An empty stomach, if the seat of a chronic lesion or active ulcer, may be somewhat irritable, and movements during the exposure be accelerated in consequence.

The position of the patient may be (1) erect, (2) prone, on the anterior surface of the body, (3) supine as in kidney position, (4) lateral or oblique.

In the lateral position it should be realised that if the patient is turned upon the side, displacement of organs, due to change of position, may give erroneous impressions in regard to the exact position of a doubtful shadow. For this reason it is suggested that all lateral negatives should be taken with the patient either prone or supine, and the tube placed opposite to the affected side, the film or plate being placed in relation to the right side in gall bladder cases. This means a couch with a lateral mechanism for the tube and plate.¹

No examination for gall stones is complete, if the stomach and duodenum are not examined also; — so important is it that indirect evidence should be obtained, that one insists, in as many cases as possible, on an examination of the gall bladder while the stomach and duodenum contain opaque material. The duodenum should be examined about an hour after the meal, and the patient should be prone. It is well to allow the subject to rest on the right side for a few minutes before turning on to the face position for the radiogram.

In this part of the technique very rapid exposures are advocated, if the effect of movement is to be eliminated. Failure to attend to this point often leads to a failure in the diagnosis of gall stones by direct or indirect sign.

¹ Observations on the lateral position and other methods of examination of the Renal and Gall Bladder Areas. Sir John Thomson-Walker and Robert Knox. American Journal of Roentgenology and Radium Therapy. Sept. 1923.

Duplicized films and intensifying screens are always used in the technique of the writer. The development is merely that of the routine, tank development being advocated in all cases. Stereoscopic radiograms are of great value, if they can be obtained with rapid exposures and no waste of time between the exposures.

STRUCTURE AND COMPOSITION OF GALL STONES

Cholesterin, of which gall stones are formed, is not secreted to any extent by the liver, but from the mucous membrane of the gall bladder and the bile ducts, especially the former. The increased production of the cholesterin is regarded as being due to a catarrhal state of the gall bladder wall, induced by some bacterial agent. When of a low grade of virulence the readiness with which the gall bladder is infected in genuine blood infections, such as typhoid fever, will be recalled in this connection.

Staphylococcal infection may be another causal condition, while the occurrence of a cholecystitis secondary to a genuine bacillus coli infection may precede gall stone formation.

Before gall stones are likely to form, it is necessary for the bile to become stagnant. It has become known in recent years that these organisms of low virulence may remain in the gall bladder for a considerable time. If collections of these organisms are added experimentally to sterile bile their presence leads to a deposit of all the constituents of gall stones.

COMPOSITION OF BILIARY CALCULI

Because of the large amount of cholesterin entering into the composition of biliary calculi, it follows that they are less dense and lighter in weight than the urinary calculi. Gall stones are largely composed of modified bile pigment and cholesterin, with at times, a small percentage of calcium carbonate, or other calcium salt.

CLASSIFICATION OF GALL STONES

(1). The common gall stone. This may be large or small, and is barrel shaped, the ends being faceted when more than one are present. There may be a number of relatively large stones, forming a cast of the gall bladder, when a large number are present, or the

stones may be small and present in large numbers, when a cast of the gall bladder is also formed. The colour varies from black or deep brown, (bilirubin), through reddish brown to green, (biliverdin), or they may be yellow, from the deposit of superficial layers of cholesterin, or white from calcium carbonate. The cut surface generally shows concentric layers of varying colour, depending on the extent of admixture with the calcium salt of biliverdin or bilirubin, the nucleus frequently being cholesterin.

(2). Pure, or almost pure cholesterin calculi. These are rather uncommon, and are mostly single, oval pale yellow stones, with a wavy-looking finely nodular surface. When cut, the surface is crystalline in appearance, with very little sign of stratification. They are rarely pure, but 95 % or more of the contents may be cholesterin.

(3). Pure bilirubin calcium calculi. These are sometimes termed »bile gravel« and are multiple blackish granules, lying in mucoid bile. When fresh, they are soft, and break under the finger: when dry they crumble apart.

(4). Calcium carbonate calculi. These are comparatively rare, are very hard, and are seldom pure. Calcium carbonate is more often found in the mixed calculi, or common gall stones.

THE GENESIS OF GALL STONES¹

Radiologists and pathologists will read with much interest a paper on the genesis of gall stones published in German by Professor T. ROVSING, of Copenhagen, in »Acta Chirurgica Scandinavica« (Vol. LVI., Fasc. 2 and 3, pp 103 and 207.)

For the past thirty years Professor ROVSING has been systematically collecting material wherewith to refute the teaching of NAUXX and others that a gall bladder area must be infected before gall stones can develop in it. In this period 530 cases of gall stones were operated upon, and in every case a bacteriological examination was made under aseptic precautions at the time of operation.

In some cases the bacteriological examination of the contents of the gall bladder were supplemented by a microscopic examination of a section of its walls, and by bacteriological examination of the interior of the gall stones. It was found that the contents of the gall bladder were sterile in 314 cases, and infected in 216. In no case in which the bile was sterile could germs be found within the

¹ Lancet. January 19th 1924.

gall stones, and in only one of the 530 cases was it impossible to demonstrate a core of pigment in the stones. The youngest patient was a child, barely one and a half years old. In this case the bile was sterile, and the common bile duct was obstructed by a quantity of coal-black grit. There was no sign of any inflammatory reaction, and Prof. ROVSING suggests that this early case gives a valuable clue to the genesis of all gall stones.

As a result of this prolonged study Prof. ROVSING is inclined to believe that all gall stones begin as a small nucleus of pigment, which forms the core of the stones. Sepsis is, in his opinion, a sequel not cause, and he dismisses as untenable the ingenious suggestion that an infected gall bladder may become sterile after the development of a stone, the germs supposed to be responsible for this development slipping away unobtrusively after the mischief is done.

His argument in opposition to this teaching hinges on an analogy. In no case of calculus of the bladder with infection of the urine has sterility been achieved without the removal of the calculus. It is, therefore, improbable that a septic gall bladder would automatically become sterile so long as it harbours a gall stone. Sepsis should, therefore, be regarded as a sequel, — a very serious sequel, — to the development of gall stones, and not as a cause thereof. Prof. ROVSING ridicules the notion that facets are produced on gall stones by their pressing on each other under the spasmodic clutch of the gall bladder. Facets, he suggests, are the expression of the intrinsic properties of the constituents of certain gall stones, and he notes that in the urinary bladder the oxalate stone is spherical, while the urate stone is a flat oval. He has also noticed that when gall stones are multiple, they are usually of the same size, and that it is very rare for more than two or three different sizes to be found in the same bladder, even when it contains many hundred stones. This observation suggests that all the stones of the same size found in a gall bladder were formed at the same time, and Prof. ROVSING believes that the period during which a crop of gall stones is created must be short. He suggests that the core of a gall stone is always, or nearly always, formed in the intra-hepatic biliary passages by the precipitation of black pigment chalk, the process being determined by a transitory »diathesis» comparable to the periodic precipitation of uric acid, uric acid salts, and calcium oxalate in the kidneys.

Two other observations deserve special mention. It has been suggested that ptosis of the viscera, notably the liver and stomach, favours the development of gall stones, by obstructing the biliary

passages. Among the 300 cases operated upon for gastrocoloptosis by Prof. ROVSING during the past twentyfive years, there were only eight in which gall stones were found at the time of operation. Further, among the 530 patients operated upon for gall stones, during the past thirty years, there were only eighteen women and one man suffering from gastro-coloptosis. The poor state of general nutrition of ptotic patients may give a clue to their comparative immunity from gall stones, which are most common in fat persons.

The other observation is also instructive. Among thirty cases of chronic biliary obstruction and jaundice coming to operation, and thirtytwo coming to necropsy, there was not one showing the slightest evidence of gall stones, whether the chronic jaundice was associated with sepsis or not. In other words, prolonged biliary stasis with jaundice does not evidently promote the development of gall stones.

THE SIZE AND SHAPE OF GALL STONES IN RELATION TO THE DENSITY

The external appearance of a gall stone is no guide to its composition or density. Fig. 1 illustrates an important point in this respect. It is the photographic representation of twentyfive gall stones of varying size and shape. A sixpenny piece is also photographed for the purpose of comparison of size. Rows C, D and E are stones which all sank to the bottom of a vessel of water. In A and B are stones which floated, and remained at the surface of the water for several hours.

Fig. 2, shows the radiographic appearances of the stones and the coin, which was used for the comparison of density. The floating stones are shown to possess considerably less density than those which sank, and a considerable number show a nuclear structure. Nearly all of the stones which sank contain a proportion of calcium salt, and should be capable of demonstration in the living body. In a number of the stones in both groups the nucleus is surrounded by a denser layer, composed of compounds of calcium with the bile pigments. The capacity for floating is evidently due to the large amount of cholesterin in the calculus. These stones will give a very faint shadow in the body, and if they are overlapped by liver or other dense substance such as muscle, the shadow may be lost altogether. Only the highest quality of negative will be capable of showing these fine gradations in shading, and only absolutely sharp

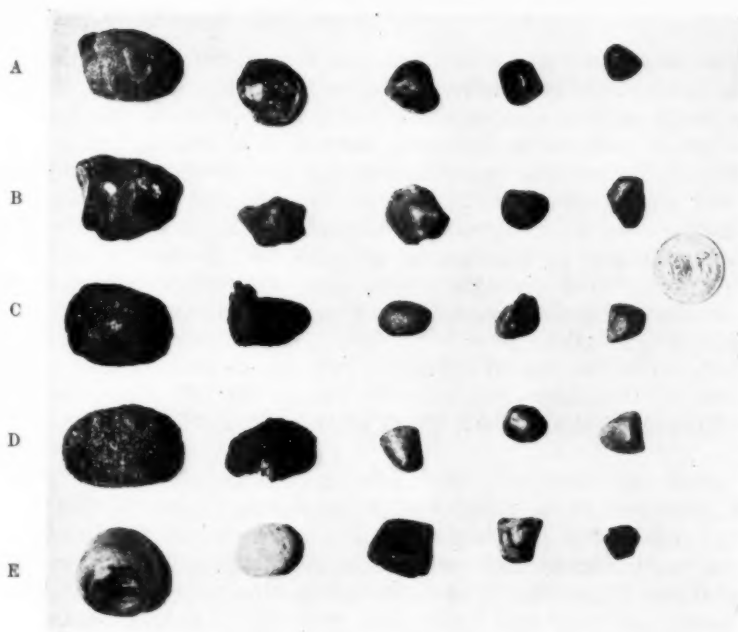


Fig. 1. Group of gall stones photographed along with a small silver coin, to illustrate the shape and size of biliary calculi.

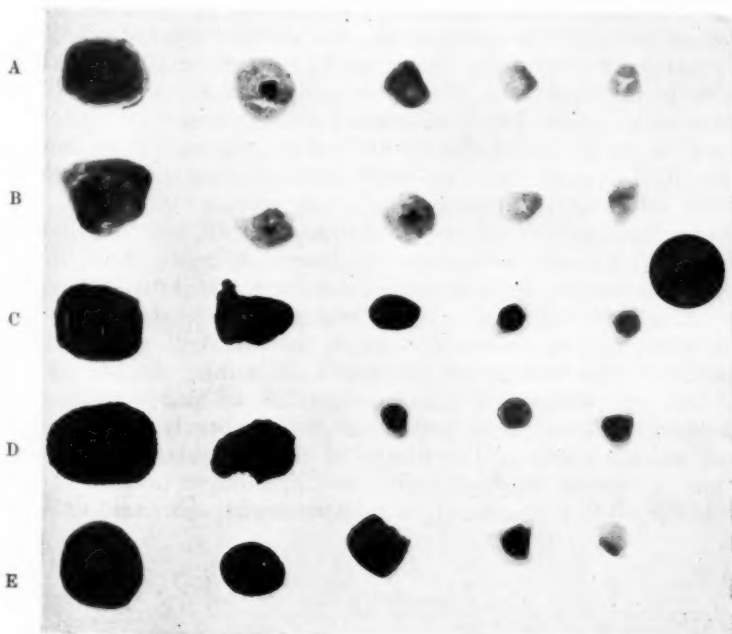


Fig. 2. Same group radiographed, to show variations in density. Rows A and B floated in water. Rows C, D, E, sank in water.

negatives can show the very fine lines caused by the thin layer of calcium salt. The possibility of such a stone giving a negative shadow must not be overlooked. It would appear therefore, that a percentage of gall stones (probably about 25 %) will not give a shadow capable of being demonstrated by the direct method. If the stones of this density are present in large numbers in a distended gall bladder, or even in a gall bladder which is contracted upon the stones, it will be possible to indicate their presence by the indirect method. It is for this reason that we attach so high a value to the work of LEONARD and GEORGE and others as a means to the diagnosis of gall stones.

DENSITY AND UNIFORMITY OF THE SHADOWS

A renal calculus will, as a rule, give a denser shadow than a biliary calculus. It is stated that a renal calculus is usually homogeneous, and that a gall stone usually shows some details of structure, the most characteristic of which is a marginal ring of increased density (Figs 7 and 8). The latter is so absolutely distinctive that it is hardly possible to mistake this type for a kidney stone. Another very distinctive gall stone shadow is that in which the marginal shadow contains inside its limits a smaller dense shadow possessing in a number of cases a nuclear structure. The latter type may be closely simulated by a renal calculus, as in Fig. 23. In this case the position of the calculus in the kidney was indicated by the lateral radiogram. A gall stone may give a very dense shadow, which it is impossible on the X ray appearance alone to diagnose definitely. On the evidence of such a dense shadow a patient was submitted to an operation for stone in the kidney. At a later examination pyelography in this case decided the issue. The stone was found to be in the gall bladder, and it was removed.

Taking the majority of the shadows of calculi, one may, however, assume that the dense homogeneous shadow is more likely to be due to calculus in the kidney, though the nature and appearance of the shadow cannot be taken as an absolute guide.

The next point for consideration is the effect of a large number of calculi in the interior of the organ containing them. (Figs. 6, 9 and 10). A distended gall bladder full of stones gives a most characteristic picture, and one which can never be mistaken for a group of kidney stones. The shape of the gall bladder may be altered but it never approximates in appearance to that of a distended kidney full of stones. In the latter organ, a branching calculus

(Fig. 24), filling the pelvis and the calices presents a picture which should never be mistaken for a distended gall bladder full of stones.

An exception to this generalization is shown in an illustration published in »Acta radiologica», in which a number of small stones occupied the pelvis and calices.¹ The stones resembled gall stones very closely, but the distribution of them in the pelvis and calices gave a picture of such value that the correct diagnosis was arrived at. The author of the paper by ingeniously projecting the shadows threw them in front of the spine. It is quite possible to do this with any stones in the kidney by changing the position of the patient and the centring of the tube into such a position that the stones come forward in the picture. It can never be done if the side in which the stones are situated is placed next to the film or plate, and when the kidney is in its normal position.

THE NORMAL AND PATHOLOGICAL GALL BLADDER

The normal gall bladder has been demonstrated on several occasions. It should be the aim in radiography of this region to show the lower border of the liver and any irregularity projecting below that border. If a normal gall bladder is distended with bile, it should show a projecting bulge at the level of the ninth costal cartilage. The density may not be greater than that of the liver. In the majority of pathological conditions affecting the gall bladder, including biliary calculi, the accompanying cholecystitis leads to a thickening of the whole of the wall of the organ. This thickened wall will show in a skiagram which is of the proper quality.

When the shadows of a collection of gall stones are demonstrated, the shape of the organ may be distinguished. The position of the gall bladder varies more than that of the kidney in different individuals. It may occupy the space between the twelfth rib and the outer border of the psoas muscle usually occupied by the kidney, and in morbid conditions it may extend as low as the crest of the ilium. The shadow is an elongated pear shape with the apex above.

It lies nearer to the twelfth rib than does the kidney shadow, and its long axis is not parallel to the outer border of the psoas muscle shadow, as in that of the kidney, but bisects the angle between the twelfth rib and the psoas. The space between the inner border of the pyriform gall bladder shadow and the outer border of the psoas shadow is much greater than that between the kidney

¹ Ein Eigenartiger Nierensteinfall — von G. Renck, Acta Radiologica 15. 11. 23.

and the psoas. Very considerable variations are found in the relation of the gall bladder to the bony landmarks, and this is not always due to the varying position of the gall bladder shadow, for the twelfth rib may be long and very oblique, so that the costo-vertebral angle is narrow. The gall bladder shadow is then seen in relation to the twelfth rib and the last costal space. The long axis may be more vertical or more transverse. In the lateral view the gall bladder lies anterior to the lumbar vertebrae and reaches as low as the third lumbar vertebra. These points ascertained by radiography are confirmed by a study of the anatomy of a cross section of the body seen at this region.

The wall of the gall bladder, which is the seat of chronic inflammation, is thickened, and frequently throws a shadow comparable in density to that of the kidney, so that the outline can be traced in the skiagrams. It does not follow, however, that where a definite shadow of the gall bladder is shown the organ is necessarily pathological. A normal gall bladder which is distended with bile, especially when the bile is more opaque than in the normal condition, and projects well below the border of the liver, will be shown in a negative of good quality. Attention was first called to this point by the work of LEONARD and GEORGE on »The Pathological Gall Bladder», and our experience confirms the observation. Failure to appreciate this important point has led to the exploration of a normal gall bladder under the mistaken impression that a defined gall bladder shadow in a skiagram must indicate a pathological condition.

In order to attain familiarity with the possibility of demonstration of the normal gall bladder, a large number of negatives of this region should be carefully studied. It will then become apparent that the outline of the gall bladder is shown in a considerable proportion of these.

The gall bladder which contains gall stones may be so enlarged as to project well below the level of the kidney in the antero-posterior view, and in the lateral, reaching as far as the middle of the body of the fourth lumbar vertebra. When greatly distended it loses its pear shape and becomes more rounded, but it never assumes the shape and outline of the kidney. It may occupy the same area as the kidney, and if only the lower half of the gall bladder shadow is seen, it might easily be mistaken for the lower pole of the kidney. A gall bladder which is full of stones may vary in size and shape at different examinations according to the quantity of bile it contains. Occasionally a distended gall bladder empties its fluid contents into the duodenum, this being accompanied by change of shape.

In chronic cholecystitis adhesions form between the gall bladder and the surrounding structures, and these tend to modify its shape when it is distended with bile, mucus or mucopus. It may assume a sausage shape, or have a curved outline, the curvature being partly outward and partly inward. When the gall bladder is distended with fluid and contains gall stones (Fig. 9), its shape as seen in the skiagram may vary from time to time. When the fluid contents are expelled, it contracts (Fig. 10). Thus it may be pear shaped at one examination and sausage shaped at a subsequent one. The organ may become fixed by adhesions to the duodenum or colon, so that the direction of the shadow will vary, and instead of pointing directly downwards or downwards and outwards, it is displaced inwards (Fig. 11).

Very rarely when inflammatory conditions have subsided, calcareous deposits may form in the walls and throw a shadow in the radiogram. This may simulate calcareous deposit on the wall of a liver abscess which has subsided, and it is difficult to differentiate between the two.

PSOAS ABSCESS

Though not at all common, this condition (Fig. 15) in certain forms may throw a shadow which simulates a distended gall bladder. Of a large number of cases of spinal caries examined, only one was found which could give rise to difficulty in diagnosis. The chief diagnostic point is the presence of caries of the spine at a higher level than the abscess. The shadow of the abscess may be long and pear shaped, and present a decided curve in its outline. In the case referred to there existed unmistakable evidence of spinal caries involving two or three of the bodies of the dorsal vertebrae. The abscess presented a long banana shaped form, narrow at its upper extremity, and widening as it proceeded downwards, until at the level of the pubic arch it showed a definite rounded outline. The sac of the abscess was distended with pus and debris, and in no part was there any indication of a varying density such as would be shown by gall stones. The diagnosis of psoas abscess was made, and confirmed by operation.

SHADOWS IN THE KIDNEY AND GALL BLADDER REGION

So far as radiology is concerned there are a number of pathological conditions other than gallstones, which present themselves

for diagnosis in a limited area in the upper abdomen. Of these lesions of the kidney and ureter come first in order of importance and frequency of occurrence. Next to lesions of the kidney come lesions of the pancreas, particularly calculus of the pancreatic duct. The duodenum may also have to be considered, and lesions of the supra-renal glands, such as calcareous deposit or growth, are occasionally the subject of diagnosis. Lesions of the liver, especially if chronic and the seat of degenerative calcareous changes, will at times present difficulties in differentiation. Calcification in the lymphatic glands and in dermoids (Figure 14) will throw dense shadows, which may be confused with renal or biliary calculi. Calcification of areas of the aortic walls may give doubtful shadows, as will also dilatation of the abdominal aorta in that region. Foreign bodies in the stomach and intestines may lead to discussion, but are easy to identify.

The chief radiographic difficulty is to distinguish between renal and gall bladder lesions, especially calculi in these organs. A urinary stone throws a uniformly dense shadow in the position of the calices, the renal pelvis, or the upper ureter. A gall stone throws a shadow in the area of the gall bladder or bile ducts, which is not uniformly opaque. There are many exceptions to these statements and, moreover, the kidney and gall bladder areas overlap. It follows that difficulties arise in recognising the nature and position of these shadows. To these difficulties we wish to refer.

METHODS USED TO DETERMINE THE POSITION OF A SHADOW IN THE KIDNEY-GALL BLADDER AREA

The stereoscopic method has many valuable applications, and the measure of success to which it may be used by an expert was demonstrated by the late Dr. MACLEOD of Shanghai.

The method is open to the grave objection that an accurate result can be obtained only where the two negatives are taken with a very short interval between the exposures. The slightest movement, respiratory or otherwise, on the part of the patient between the exposures, may lead to serious error in the subsequent calculations. And when all has been accomplished it is only possible to say that the calculus lies at a definite depth from the skin surface, which during the exposure was in juxtaposition with the sensitive side of the film or plate.

To localise accurately the depth of the shadow from the surface is, nevertheless, of definite clinical value, and when the different

organs lie in superimposed planes the knowledge of the plane proper to each organ will give an additional factor necessary for the localization of one or other organ.

The valuable table prepared by Dr. J. METCALFE and the late Dr. KEYS-WELLS gives the following data, which are useful in estimating the depth measurements either in stereoscopy or with negatives obtained in three positions:

Thickness of posterior abdominal wall from skin surface to

- (1). transverse process of third lumbar vertebra = 4 to 5 cm.
- (2). anterior level of third lumbar vertebra = 11 cm.
- (3). anterior level of psoas muscle = 15 cm.

From these data it is possible to estimate whether a shadow represents a stone inside or outside a kidney which is normal in position and size. The position of the gall bladder in relation to the abdominal wall is not given in this table. If the thickness of the abdominal wall at a point 1 cm. on either side of the middle line at the level of the umbilicus is taken as 3 cm., the fundus of the gall bladder is known to lie close to the posterior surface of the anterior abdominal wall.

The gall bladder is from 7 to 10 cm. long, and is directed backwards and towards the middle line. A gall stone may therefore be situated at any point between 3 cm and 13 cm from the anterior surface of the abdomen. It must be admitted, however, that the organs do not occupy exactly superimposed planes, but have a much less regular relationship, and further, an organ such as the kidney does not, on account of its mobility or abnormal mobility, or from its enlargement in disease, necessarily occupy the plane normally assigned to it, or retain its accepted relationship to other organs. It follows therefore, that there are limitations in the stereoscopic method that do not apply to the lateral method.

A gall stone situated at the neck of the gall bladder (Fig. 12), or in the cystic or common duct, will have a position very different from that of a stone in the body of the gall bladder, especially if the latter is distended and displaced forwards and downwards. It may be in front of the kidney shadow and cause great difficulty in diagnosis, even when all positions are employed. The stone in the common duct will lie just in front of the anterior border of the lumbar vertebrae when the patient is examined in the lateral position.

Some of the difficulties that arise are illustrated by the radiograms obtained during the examination of a case which came under the notice of the writer. It was determined definitely that a large shadow in the renal region was due to a calculus filling the renal

pelvis and extending into the calices. At the lower limit of the renal calculus a large oval shadow was seen (Fig 13). This had a central opacity surrounding which was a less opaque area, and at the extreme periphery an irregular dense outline was seen. Doubt arose regarding this shadow, although it certainly had the characteristic appearance of a large gall stone. In the antero-posterior view first taken, it was overlapped in part by the calculus in the kidney, and the shadow of the kidney also overlapped it. But in a subsequent exposure it lay below the shadow of the kidney stone. An opaque catheter was introduced into the ureter. It passed the lower shadow and entered the kidney at the upper limit of the renal calculus. A lateral radiogram showed clearly that the doubtful shadow lay in front of the spine, and the diagnosis of gall stone was made. At operation the kidney was removed by the lumbar route, and was found to contain large calculi in branching arrangement. The gall bladder was opened by the anterior route, and one large and fifty small stones were removed. The examination of the case shows how very thorough must be technique when doubtful conditions exist. In the radiograms taken in the antero-posterior and the postero-anterior positions several faint shadows due to biliary calculi were seen, but the majority of the small biliary calculi were lost in the renal shadow and that of the kidney stone. The lateral position and the opaque catheter gave much help in the diagnosis. Stereoscopic radiograms would have been useful in this case, though it is doubtful if one could have made any definite statement unless accurate depth measurements had also been made.

SIZE AND SHAPE (Figs 1 and 2)

Both renal and biliary calculi may attain a very large size, and both may, when large, have an oval or rounded shape. A large round or oval shadow, if thrown by a kidney stone, will be accompanied by a large kidney, which is really palpated in the loin, for in such cases the kidney is usual dilated with urine or pus. It may be stated, therefore, that where a large oval or round shadow appears in the loin without urinary symptoms and the kidney is palpable, the shadow is more likely to be thrown by a gall stone than by a kidney stone. There are however, some remarkable exceptions to this generalisation. A wedge shaped shadow is characteristic of a stone in the renal pelvis. An irregular or branching shadow is never due to a biliary calculus and a branching shadow is cer-

tainly renal. The difficulty seldom arises over the large calculi, but over a small oval or round shadow, which might be thrown by a biliary calculus.

COMPARATIVE DENSITY AND UNIFORMITY OF THE SHADOWS

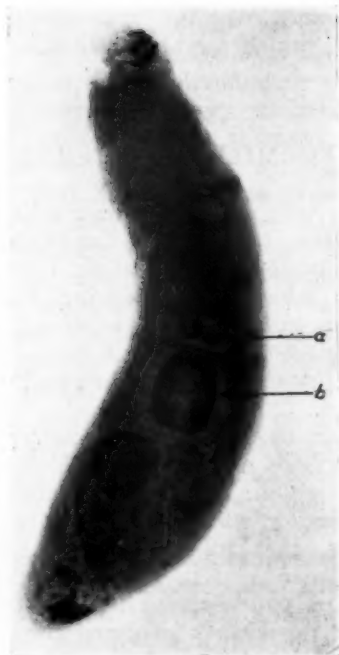
As already stated a renal calculus will, as a rule, throw a heavier shadow than a biliary calculus. A renal calculus shadow is usually homogeneous, and a gall stone usually shows some slight detail of structure, the most characteristic of which is a marginal ring of increased density. This ring, together with a central nucleus, gives a shadow which is peculiarly characteristic of a gall stone. But there are misleading shadows where the character of the renal stone shadow resembles that of a gall stone.

An example was a case of stone in the kidney (Fig. 22), where the nucleus and denser margin were both clearly seen, which gave rise to serious doubts regarding its position. On the other hand, a gall stone may give a very dense shadow which would indicate, if the density were taken as a guide, that its position was in the kidney.

On the evidence of such a uniformly dense rounded shadow in the right renal region, a patient had the kidney explored for stone with negative results. When examined later she complained of pain in the right upper abdomen, but had never suffered from hematuria or jaundice. Pyelography showed that the shadow lay apart from the renal pelvis and calices, and the gall bladder was opened, and the stone removed.

Faint shadows in the gall bladder and kidney regions have been overlooked because the type of negative does not show sufficient detail. When the negative is very dense from over-exposure, over-development or both, a very powerful illuminant will reveal the evidence of a shadow, which should be helpful. The detail of gall stones may be faintly perceptible to ordinary vision in ordinary illumination, and oblique illumination may give assistance. Coloured screens may be interposed between the negative and the source of light. Such faint shadows have generally been attributed to bowel contents or other extraneous matter. Experience shows that although a number of calculi may be present in the gall bladder, only a small number may throw a shadow. Yet a single distinctive shadow is sufficient for diagnosis. (Figures 3 a, 3 b, 7 and 8.)

It has been pointed out by CARMAN that gall stones may be of less density than the medium in which they lie, and under these



3 a



3 b

Figs 3 a and 3 b show the radiogram of the gall bladder after removal, and a drawing of the gall bladder with the stones in situ.

This case illustrates the point that it may be only possible to show one shadow in a gall bladder containing a collection of stones. In a radiogram of these stones in situ, only one definite shadow was obtained.

conditions the gall stones are indicated by an area of less opacity than the surrounding structures. They will therefore, show on the negative as darker areas. And this especially occurs in gall stones lying in a bladder distended with bile, pus or muco-pus. In this relationship it may be noted that Dr. SIMON refers to a case where the lesser opacity gave rise to suspicion of the presence of a stone situated in the common duct. Similarly in the opaque meal examination a deformity of the opaque material may be caused by a gall stone of low opacity.

The following experiment demonstrates conclusively the accuracy of these observations (Fig. 4). A large gall stone composed chiefly of cholesterin was X rayed in the usual way. It was then placed against a film, and a box containing water was placed between it and the X ray tube. A very definite »positive» shadow was obtained.

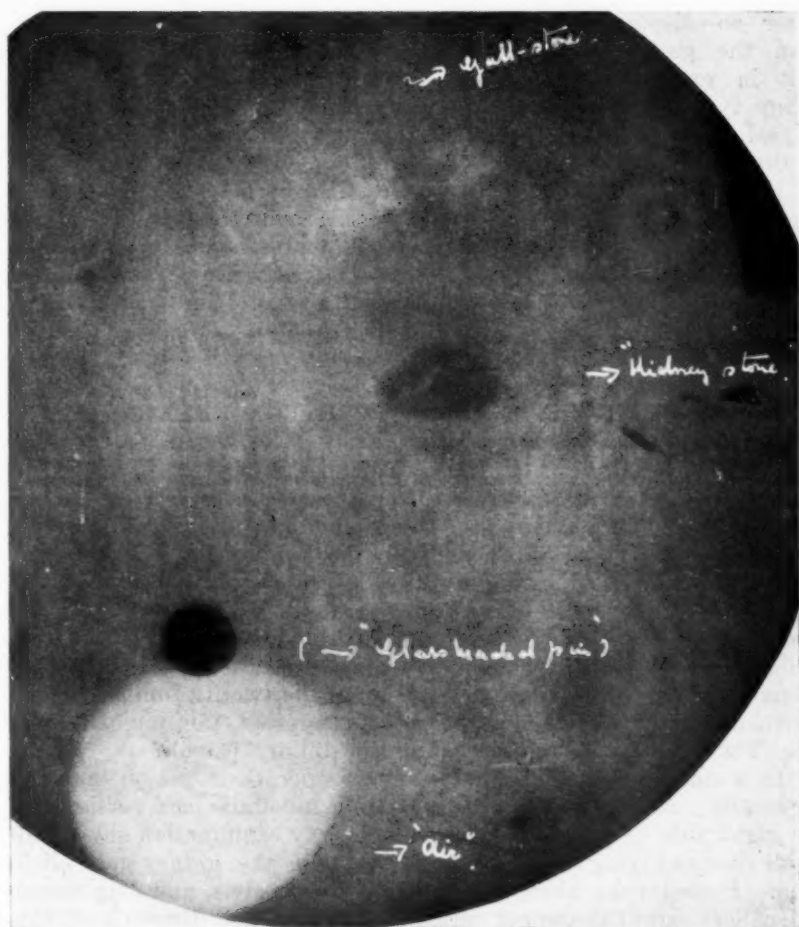


Fig. 4. Result of experiment to determine relative densities of air, cholesterol gall stone, kidney stone, and glass push pins. Note the negative type of shadow cast by the cholesterol gall stone. Compare this with that from the air collection.

These objects were placed in a tank 10 cms from back to front.

The stone was then wrapped in a thin sheet of gutta-percha tissue and placed in the water close to the distal side of the box. The negative produced was a 'negative' shadow. The water had absorbed relatively more of the radiations than the gall stone. The gall stone displaced a volume of water equal to its bulk, and the quantity of

water so displaced had a relatively higher absorption equivalent than the gall stone which displaced it. It is, therefore, possible that in examining for the presence of gall stones, we look for the wrong type of shadow, and may altogether miss the stone if we fail to realise that a small »negative« opacity may indicate the presence of the object for which we are searching.

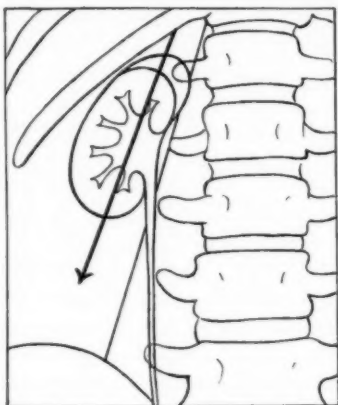
In this relationship it is interesting to note that Dr. LYNHAM whose attention has been called to this point by the experimental work described, recently diagnosed the presence of gall stones on the negative shadow. Since the above was written two cases of a similar nature have been diagnosed by Dr. THOMSON, and Dr. ROWDEN J.R.

GROUPING OF SHADOWS AND THE EFFECT OF RESPIRATION

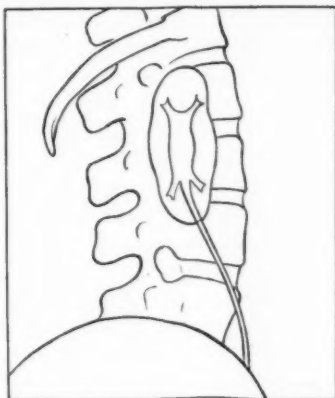
When a number of shadows are present their arrangement will conform, to some extent, to the shape and axis of the cavity in which they lie (Fig. 5). Calculi in the kidney and calices tend to radiate outwards from the position of the pelvis which lies at the edge of the psoas at the level of the transverse process of the second lumbar vertebra. Shadows in the gall bladder, on the other hand, radiate downwards or downwards and outwards from the angle formed by the twelfth rib and the body of the twelfth lumbar vertebra. When a line of calculi can be traced, therefore, the line of the renal calculi would tend to cross that of the biliary calculi.

In a male patient there had been two operations one on the kidney for mobility, and an abdominal exploration, indefinite pain persisted over the right side of the abdomen. The X ray examination showed four small shadows lying like a string of beads in the kidney-gall bladder area. Pyelography showed a normal kidney pelvis, and demonstrated the calices except the upper calyx, the position and direction of which, radiating from the pelvis, was represented by the string of shadows. The axis of this line of shadows crossed that which would represent a string of calculi in the gall bladder ducts. The shadows were also denser and more uniformly opaque than would be expected in gall bladder stone shadows, and the diagnosis of kidney stones was made upon these points, and subsequently confirmed by abdominal exploration and examination of the gall bladder.

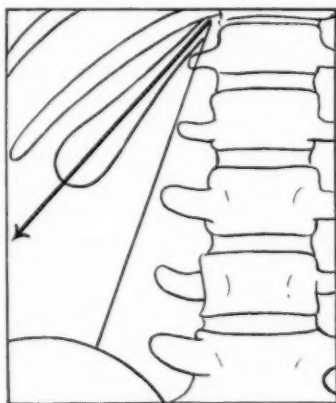
The grouping of a large mass of renal calculi into a main mass in the pelvis with radiating branches in the calices, and the mosaic of shadows produced by the gall bladder filled with gall stones, are



To show position of kidney and supra-renal body pelvis of kidney and ureter in relation to bony landmarks. The arrow indicates the direction of movement of the kidney with a deep inspiration.



Lateral view of renal area, with position of kidney and ureter indicated. To determine the position it is necessary to inject the pelvis, calices and ureter with opaque material and take a lateral radiogram.



To indicate position of gall bladder in a radiogram. The arrow is drawn through the long axis of the gall bladder. Movement of shadows in the gall bladder with respiration does not quite follow this line as it does in the kidney picture, because the gall bladder is situated in relation to the liver, and its movement is influenced by the movement of the liver, that is almost directly downwards.

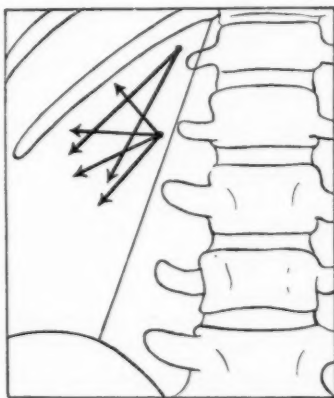


Diagram to indicate the line along which stones in either kidney or gall bladder pictures may be arranged. Note the radiating lines in the kidney diagram.

Fig. 5. Diagrams of kidney and gall bladder regions by kind permission of Sir J. Thomson-Walker F. R. C. S.

each so characteristic of the respective organs as to leave no margin of error. In some difficult cases where only one shadow is present, the following method has proved useful. Two exposures are made on one plate, the one in full expiration and the other in full inspiration. The direction and extent of movement are noted. The kidney stone moves downwards and outwards, and the extent of the movement is less than that of the gall bladder under the same conditions, i. e. where the plate is nearest to the spine, as in the usual kidney position. The movement of the shadow of the gall stone, which is lying free in the cavity and at the lowest point of the gall bladder, will be almost directly downwards with a slight displacement inwards and will show a greater amount. A gall stone in the common duct or cystic duct is fixed. Its displacement will be less marked on deep inspiration, and its line of movement will approximate to that of the kidney stone.

PYELOGRAPHY

By pyelography the shadows which lie within the kidney area, and are actually within the limits of the kidney shadow, may be proved to lie outside the kidney. The shadow of a kidney stone will lie engulfed in, or at least be continuous with, the shadow of the renal pelvis or one of the calices. A shadow which lies apart from the pelvis or calices, as shown by pyelography, is not thrown by a renal calculus. The so-called cortical stone, a stone embedded in the renal cortex, and not connected with the calyx, has no existence outside the older textbooks. Where therefore, the suspicious shadow is shown to lie apart from the pelvis and calices as shown by pyelography, the diagnosis will be a gall stone and not a kidney stone. But where the shadow is continuous with or superimposed upon a calyx or the pelvis, the stone may be, and usually is, a kidney stone. Where doubts exist in regard to this point, they are cleared up by the lateral position.

When pyelography shows the presence of a stone in the kidney the localization of the stone to the calyx in which it lies, or to the pelvis, is accurate and of much assistance to the surgeon when the stone is small and its removal is proposed. But here again there is a source of fallacy, for in the experience of the writer a small stone, demonstrated by pyelography to lie in a calyx at the upper pole, may be found at operation to lie in a calyx at the lower pole or in the pelvis. Too much reliance, therefore, cannot be placed upon this form of localization as an aid to operation.

With an opaque catheter in the ureter and the renal pelvis filled with opaque material, the shadows thrown by calcified glands are conclusively shown to lie extra-renal, and where a single shadow is present there is no difficulty in demonstrating that it is outside the ureter.

LATERAL RADIOGRAPHY AND PYELOGRAPHY

In lateral radiography with the kidney in its normal position and where no great enlargement of the organ is present, a kidney stone will throw a shadow on that of the body of the second lumbar vertebra. A stone occupying the extreme limit of a calix may throw a shadow which appears behind the body of the vertebra, but this is a rare finding, and will not give rise to confusion with any other shadow. The two conditions which may cause confusion with the shadow of a kidney stone, are gall stones and calcified abdominal glands. The gall stone lies well in front of the shadow of the vertebral bodies, usually at the level of the upper three lumbar vertebrae, but sometimes as low as the fourth lumbar vertebra.

The shadows of calcified abdominal glands may lie in the kidney region, but are usually lower down, and in the lateral view, in front of the bodies of the third and fourth lumbar vertebrae. An example of such a condition occurred in a lady who had, a few years previously, been operated upon for stone in the right kidney. The kidney and stone had been removed. Recently she experienced symptoms similar to those previously complained of, and a doubt existed as to their cause. A negative in the antero-posterior position showed a large shadow in the renal region, situated near the position of the lower pole of the left kidney, and lying in front of the ureter. A lateral radiogram demonstrated the shadow some distance in front of the ureter, and therefore not causing pressure symptoms. In cases where any doubt exists as to whether a shadow or group of shadows is thrown by renal calculi or by calcified glands, antero posterior and lateral pyelography should be carried out. The exact relation of the renal pelvis and of the ureter to the doubtful shadows is demonstrated clearly.

Objections have been raised to the use of the lateral method. It is difficult to get satisfactory negatives from stout patients. This is a matter of technique, and applies to the antero-posterior as well as to the lateral position. An improving technique will show an increasing number of successful radiograms in stout persons. It has been stated that it is not possible to demonstrate gall stones in the

lateral position. This is not the case. It is not possible to show all the gall stones in either position, but a gall stone, which in the antero-posterior position shows a definite shadow, should be almost as readily shown when a good lateral negative is produced. Most renal calculi will show in the lateral position through the shadow of the spine (figure 25). Should a shadow, which is very distinct in either or both of the first two positions, not appear in front of the spine in the lateral, we may reasonably conclude it is not a gall stone. An exception which might cause some difficulty would be a small gall stone in the common duct close to the duodenum. The shadow might be near enough to the spine to suggest the possibility of a kidney. Pyelography is of great value in such a case. The clinical symptoms may decide the diagnosis apart from the X ray examination, but exploration may be necessary to settle the diagnosis.

A practical point of some importance in the technique of gall bladder and kidney radiography is to realise the type of negative at which it is desirable to aim. The earlier kidney radiography led to the production of a number of first class negatives of that region, and no better technical work has been produced in recent years. The detail of bone is remarkably good in these negatives, the aim of most workers being to produce a high class negative with strong contrasts in the bones. This type of negative is quite good for the demonstration of stones of considerable density and of fairly large size. The smaller and less dense stones are likely to be missed, while gall stones are rarely shown in this type of negative. It is considered better in later work to aim at a negative which will give good detail in the softer parts, the bony detail being a secondary consideration. In development it is well not to carry the process too far, as a fairly thin negative is required.

THE VALUE OF THE LATERAL POSITION IN THE RADIOGRAPHY OF THE GALL BLADDER AND RENAL AREAS

This position and its relative importance has been dealt with at considerable length by SIR JOHN THOMSON-WALKER and the author in a paper published in the *American Journal of Roentgenology*, September 1923. Portions of that paper have been incorporated in the text of the present paper. The writer would especially acknowledge the valuable help of Sir JOHN THOMSON-WALKER in this work.

The authors have found the position of very great value when the differential diagnosis of lesions in the right upper quadrant of

the abdomen has to be considered. The use of the lateral position has not been taken advantage of by many workers until quite recently, largely because of the difficulty of obtaining satisfactory radiograms in the lateral position. The difficulty is not a real one with modern apparatus, indeed in very stout patients it may be easier to obtain a good radiogram in this position than in the antero-posterior position, for the reason that if compression is used in the lateral position it is possible to get the compression tube well into the abdominal fat and closely approximated to the film (Figure 17). Statistics or percentages of successes are fallacious arguments in most things, and particularly in gall bladder records, but if one might venture to quote figures with little fear of being contradicted it might be stated that in cases of gall stones, in which a positive diagnosis has been made in the antero-posterior position negative, at least 75 % of these can be recorded in the lateral position. In this rapidity of exposure is even more essential than in the other positions. Movements of the parts and particularly of a pendent active gall bladder will frequently obscure the details which are essential for a positive diagnosis.

It is now evident that in a considerable percentage of the cases examined, the observations of a number of definite pressure effects would lead to a correct diagnosis. Another observation of great importance is that attributed in the first place to CARMAN, who drew attention to the shadow of a non opaque stone, when it was situated in a gall bladder full of bile or mucopus. A careful investigation of this important clinical observation led to the demonstration of the negative shadows. We must look out for two types of shadow in gall bladder work, the positive and the negative shadow.

DIRECT AND INDIRECT SIGNS OF THE PRESENCE OF GALL STONES AND PATHOLOGICAL CONDITIONS OF THE GALL BLADDER

Perhaps the greatest advance in gall bladder diagnosis was made when LEONARD and GEORGE published their important work on the pathological gall bladder. This work, as a piece of pure reasoning based upon hitherto unrecognised effects in the gall bladder area, stands on a very high level. It was led up to by the recognition of the fact that a percentage of gall stones were so transparent to X-rays that but little hope existed of ever being able to demonstrate their presence by the direct method. Research in the future may indicate how true is this assumption, but the hope may be expressed

that a still greater percentage of gall stones may be shown by the direct method.

The assumption that a non opaque gall stone or stones might be indicated by pressure effects upon adjoining organs was the result of brilliant reasoning, and it was quickly demonstrated that another valuable aid to gall stone diagnosis was forthcoming.

The publication of LEONARD and GEORGE's work was speedily followed by the brilliant investigations of KIRKLIN, and soon the diagnosis of gall bladder lesions was placed upon a very sound footing.

As already stated a normal gall bladder may be demonstrated when it is distended by bile, if it projects beyond the lower border of the liver, and the negative is made when the gall bladder is in a phase of positive tension. The same observation applies to the pathological gall bladder with or without gall stones. If in a state of positive tension it will be of considerable size with the gall stones lying, if they are free, near the fundus. A gall bladder in this state of positive tension is more likely to give rise to pressure deformities on the stomach and the duodenal shadows (Fig. 16). than one which has a minus tension. That these phases can be demonstrated on the same case is beyond doubt. The half shadow described by Dr GEORGE is due to pressure of the tense gall bladder upon the barium filled duodenal cap or pyloric antrum. It may show in one or more negatives and may be absent at a subsequent examination. It can only be persistently present when the outlet to the gall bladder is permanently occluded.

The case with which the pathological gall bladder without gall stones can be shown will depend upon the opacity of the bile and the degree of tension, i. e., the quantity of bile within the gall bladder. The same applies to the apparently normal gall bladder, though it is asserted by several authorities that a gall bladder, which is rendered visible by its contents or thickening of its walls, or both, is necessarily pathological. The question cannot be settled definitely until we are in a position to define much more accurately what we mean by a pathological gall bladder.

Another interesting point in this relationship will be the position of a number of calculi in a greatly distended gall bladder. If they are free they will assume a position in relation to their density. The heavier and more opaque will tend to sink into the fundus, the lighter or less opaque will assume a higher position according to the degree of opacity, and the pure cholesterin stone will rise towards the cystic end of the gall bladder. When radiographed, these stones may show all varieties of density from the very opaque positive shadow to the very faint or less positive or to the purely nega-

tive shadow showing in the general shadow as a darker area. (Fig. 3 and 4). These points have been referred to by a number of other workers, the first of whom was Dr. CARMAN.

MOVEMENTS OF THE ORGANS DURING THE EXPOSURE.

The time factor in radiography of the gall bladder and renal areas is of the greatest importance. While it is admitted that a percentage of gall stones and most of the urinary calculi, if they are of any size, can be demonstrated by the comparatively long exposure, especially if the patient keeps absolutely still, and thorough compression is used, we would emphasize the need for instantaneous exposures in all work of this kind for the reason, that if small calculi are present, they may not be detected if either voluntary or involuntary movements occur during the exposures. In particular, in gall stone work where very fine shades of grading or fine lines may be the only indication of the presence of gall stones or of a pathological condition of the gall bladder walls, movement, if it is at all rapid will obliterate all evidence of even a very opaque body like a calcium calculus or a foreign body.

A striking proof of this contention is found in the example of a bullet in the interior of the heart. If a long exposure is given for this condition the pulsating movements of the heart will, if the foreign body is free in the cavity, completely obliterate any X-ray evidence of its presence, while an instantaneous exposure will give a sharply defined outline of the bullet.

That movements of the gall bladder can obliterate the evidence of the presence of gall stones is indicated by the illustrations given later. The instantaneous exposure is, therefore, of very great value, since it eliminates a number of sources of error, and gives in nearly every instance a sharply defined outline. The risk of movement of the patient during the exposure, spoiling the negative is also cut down to a minimum. So in all work on the gall bladder and kidney areas the shortest possible exposure consistent with photographic excellence is urged, and it is confidently asserted that if all examinations were carried out in the way indicated a larger percentage of direct diagnoses of gall stones would quickly be obtained.

In order to emphasize the urgent need for the adoption of a very rapid exposure in the technique it might be profitable to consider the types of movement which are likely to occur in these regions during the exposure.

The first and most common cause of failure to obtain sharp negatives is voluntary movement of the limbs, raising of the head or

arms, or respiratory movements. It is not uncommon for the patient who is asked to stop breathing to inhale and expand the lungs prior to holding the breath. Many of the exposures are made while the patient is preparing to hold the breath. An error of this kind is easily prevented by a short preliminary drill in breathing. The patient should be allowed sufficient time to settle down before the exposure is made. It should be realised that if the exposure is a long one, a number of patients can suspend respiratory movement only for a few seconds at a time, and that even where there has been no obvious movement during a long exposure, there are in fact fine involuntary movements of the diaphragm occurring just prior to a voluntary movement, and that these may be sufficient to spoil a good negative.

It frequently happens that after all precautions to avoid the effects of movement during exposure, the radiogram shows evidence of decided movement of the parts chiefly concerned in the diagnosis of a gall bladder lesion. The patient has been drilled into the necessary quietude. The breathing has been suspended during the whole of the exposure time, as is shown clearly by the absolute sharpness of the bony parts, the spine and ribs being particularly well defined. We must look, therefore, for some other cause than the voluntary movements of the patient or respiratory movements. What are the factors in the region which are beyond the control of the individual? There is the pulsation of the large vessels, notably the aorta and its large branches. In a relatively long exposure this alone is capable of rendering the very fine shadow of a thinly coated calcium gall stone invisible in the negative. The only manner in which this form of movement can be eliminated is to make the exposure as short as possible. Instantaneous exposures are always preferable if they are attainable.

There are other involuntary movements in the region, these being due to the pyloric end of the stomach and the duodenum, particularly the first part of the latter. An actively contracting irritable stomach may by its movements make such a commotion in the region that fine shadows are confused and often rendered valueless. In this variety the short exposure is again essential.

MOVEMENTS OF THE GALL BLADDER AND DUCTS.

The gall bladder is a musculo-membranous sac possessing considerable power of movement. This, especially when the patient is suffering from colic, may give rise to rhythmical movements of a propulsive type, which will mask the outline of any structure within

its walls. This may be an explanation of the failure to demonstrate gall stones or the gall bladder outline in negatives which are in other respects good. It is also a strong argument in favour of the short exposure. In the examination of the gall bladder for calculus, if the exposure is made during these movements, the absence of any shadow might lead to a negative diagnosis of gall stones. It is possible to avoid a mistake of this kind by taking a number of negatives with an interval between.

It must be owned that until recently the writer had not thought of the possibility of gall bladder movements negating the presence of gall stones in the radiogram, though from time to time negatives have been met with in the routine examination which showed no shadow, when undoubted shadows were found on negatives taken from the same patient on another occasion.

One of the best gall bladder cases met with in a large series of examinations was nearly reported as negative of gall stones because the first negative gave only a confused shadow, which might readily have been reported on as bowel contents. Subsequent pictures taken with a much shorter exposure gave a positive diagnosis of multiple gall stones. (Figs 9 and 10).

Quite recently a series of gall stone shadows were obtained during the routine examination of an opaque meal. (Figs 18, 19, 20 and 21). They were well shown in each negative. The negative taken in the gall bladder position recorded no trace of their presence. A lateral negative in the upright position in the routine series showed the stones clearly. A second lateral with the patient lying on the right side gave no evidence of the gall stones, though in other respects the negative was infinitely superior from the photographic point of view. At an examination a few days later, it was only with extreme difficulty that a reasonably good negative could be obtained in the prone gall bladder position (Figure 18). Another negative in the same position gave the shadows in quite an altered position, very much nearer to the spine, and in part overlapped by the lumbar vertebrae. The exposures at this examination were for technical reasons rather long, 3 to 5 seconds, while those in the routine opaque meal examination were approximately one tenth of a second. In one or two of the negatives taken with the longer exposure a faint irregular shadow showing no differentiation of structure was seen. From these observations one is compelled to the opinion that movements of the gall bladder and ducts during the exposure may give an erroneous value to the observation. They also demonstrate clearly the need for rapid exposures in all examinations of this region.

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Fig. 6. A group of small gall stones in a gall bladder. The gall stones were seen clearly in the lateral picture.

Fig. 7. A single gall stone showing typical peripheral density. Radiogram by Dr Sankey.

Fig. 8. Several gall stones in a pathological gall bladder. In this radiogram a large stone is shown through the thickness of the lumbar spine. This case illustrates an important point in diagnosis; shadows may be lost in the density of bone, but if care be taken to examine the negatives it is possible to differentiate even a gall stone through bone.

Fig. 9. Multiple gall stones. This radiogram was the last in a series, the earlier of which showed hardly any X ray evidence of gall stones, probably owing to movement during a relatively long exposure. The final diagnostic radiogram was obtained with an exposure of 1 second on a plate with one intensifying screen.

Fig. 10. Radiogram taken in kidney position. From same patient, after 14 days' interval. Note the change in the shape of the gall bladder. This change was accompanied by a marked change in the symptoms; when radiogram Figure I was obtained the patient had almost persistent pain amounting to a mild colic. The later radiogram was taken when pain was absent. The gall bladder had emptied its fluid contents, and its walls had contracted upon the collection of gall stones.

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Fig. 11. A pathological gall bladder, showing adhesions to the liver and duodenum. No X ray evidence of gall stones. Confirmed at operation.

Fig. 12. Multiple gall stones; showing outline of gall bladder.

Fig. 13. A large branching renal shadow composed of a group of stones, one very large one filling the pelvis and calices. Below is the shadow of a large stone showing a central nucleus and a peripheral density. At operation the kidney was removed. About 50 small stones and one large one were removed from the gall bladder.

Fig. 14. An atypical appearance in the right side of the abdomen. The diagnosis, after considerable difficulty, was finally made. Dermoid cyst, showing teeth and bone. The large air-like appearance surrounding the dense shadow was found to be due to the distention of the cyst by hair and thin subaceous like fluid.

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Fig. 15. Psoas abscess.

Fig. 16. Lateral view of same case as figure 12, with opaque material in stomach and duodenum. Note the position of gall stone anterior to stomach, also deformity of duodenal cap.

Fig. 17. Lateral view from a case multiple gall stones, showing position of gall stones well in front of the anterior border of the spine.

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Fig. 18-21. A series of radiograms to illustrate movements of the gall bladder. This case is referred to in the text. It is worthy of note that during the examinations the patient was suffering from a moderate degree of colic, almost continuous pains with intermittent colic.

Fig. 19. Miss P. »1 hour».

Fig. 20. Miss P. »5 hours».

Fig. 21. Miss P. »7 hours».

} after ingestion of opaque meal.

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Fig. 22. Shadow on the right side, situated in the renal area, showing details of structure, simulating the appearance of a gall stone. Examined by all methods and no definite conclusion arrived at, though in the end it was considered to be situated in the kidney. The situation was confirmed later in the kidney.

Fig. 23. Bi-lateral renal calculi, showing details of structure; on the right side a large calculus gives good detail of the structure. This might well be mistaken for a gall stone. The diagnosis was settled by the lateral radiogram.

Fig. 24. Branching renal calculi filling the pelvis and calices of the kidney.

Fig. 25. A group of renal calculi, showing through the lumbar vertebrae in the lateral position.

SUMMARY

The chief point to recognise in technique is the need for rapid exposures, and the complete immovability of the part under examination. The question of purgation just prior to an examination and the time when food is given, are of importance.

The composition of the gall stone has an important bearing upon the result of a radiographic examination. Cholesterin, when pure, throws only a very faint shadow, which is readily obscured by superimposed structures, such as the liver, kidney, etc, therefore it is rare to demonstrate a pure cholesterin stone by the direct method. Pure cholesterin and stones containing only a small percentage of calcium salts float in water, those with a larger percentage sink. This in a rough way gives the percentage of gall stones demonstrable by the direct method.

The differential diagnosis in lesions of the right upper quadrant of the abdomen is extremely difficult, on account of the number of important organs in that region; hence every known method must be employed in the investigation of difficult cases; these entail the use of pyelography amongst others.

Lateral radiography and pyelography are of the first importance in the distinction between kidney and gall stones, no examination is complete if this has not been done.

The reason of the difficulty of roentgen diagnosis of gall stones is largely one of density of the gall stones, therefore the argument is advanced

that if any movement occurs during the exposure it may modify the radiographic value of the negative. Movements are described as voluntary and involuntary; of the latter the possibility of movement of the gall bladder and ducts during the exposure may be sufficient to spoil a good negative. Movements of other organs in the region, such as the duodenum and stomach, aorta, etc., may have a similar effect. Consequently it is urged that the exposure in work of this kind must be as short as possible.

ZUSAMMENFASSUNG

Als wichtigstes Moment der Technik ist die Notwendigkeit rapider Exposition zu erkennen und die vollständige Unbeweglichkeit der betreffenden Partie während der Untersuchung. Von Bedeutung ist ferner die Frage der Purgation kurz vor der Untersuchung und die Zeit für die Verabreichung von Nahrung.

Die Zusammensetzung des Gallensteines ist von wesentlichem Einfluss auf das Resultat der Röntgenuntersuchung. Cholesterin, das will sagen reines Cholesterin, wirft nur einen sehr schwachen Schatten, der durch darüberliegendes Gewebe, wie das der Leber, Nieren etc. leicht verdeckt wird; deshalb ist es so selten möglich, einen reinen Cholesterinstein durch die direkte Methode zu demonstrieren. Reines Cholesterin und Steine, die nur einen kleinen Perzentsatz von Kalziumsalzen enthalten, flottieren im Wasser, solche mit einem höheren Perzentsatz sinken unter. Das gibt in grober Weise den Perzentgehalt von Gallensteinen, wie er durch die direkte Methode zu demonstrieren ist.

Die Differentialdiagnose für Läsionen im rechten oberen Quadranten des Abdomens ist infolge der Anzahl der wichtigen Organe in dieser Region äusserst schwierig. Darum müssen zur Untersuchung schwieriger Fälle alle bekannten Methoden herangezogen werden, unter anderem die Pyelographie.

Laterale Röntgenaufnahmen und Pyelographie sind von der grössten Wichtigkeit für die Unterscheidung zwischen Nieren und Gallensteinen — keine Untersuchung ist vollständig, wenn diese Methoden nicht zu Hilfe genommen wurden.

Die Schwierigkeit der Röntgendiagnose von Gallensteinen beruht hauptsächlich auf der Dichte derselben, darum wird der Satz aufgestellt, dass jede Bewegung, die während der Exposition eintritt, den radiographischen Wert des Negativs verändern kann. Was die Bewegungen betrifft, werden willkürliche und unwillkürliche beschrieben; von den letzteren kann die mögliche Bewegung der Gallenblase und der Gallengänge während der Exposition genügen, ein sonst gutes Negativ unbrauchbar zu machen. Bewegungen anderer Organe der Region, wie des Duodenums und des Magens, der Aorta etc., können eine ähnliche Wirkung haben. Es ergibt sich daraus die Forderung, dass die Exposition bei Untersuchungen dieser Art so kurz als möglich sein muss.

RESUMÉ

Le point principal dans la technique radiologique est la rapidité de l'exposition et l'immobilité complète de la partie examinée. La question de purgation précédant immédiatement l'examen et le moment où la nourriture a été donnée est d'importance.

La composition des calculs biliaires a une grande influence sur le résultat de l'examen radiographique. La cholestérine, quand elle est pure, ne jette qu'une ombre très faible, facilement obscurcie par des couches superposées, comme le foie, le rein, etc. Il est donc rare de pouvoir montrer un calcul de cholestérine pure par la méthode directe. La cholestérine pure et les calculs contenant seulement une petite proportion de tels calciques flottent dans l'eau, ceux d'un taux plus élevé, content. Ceci donne grosse mode le pourcentage des calculs biliaires susceptibles d'être constatés par la méthode directe.

Le diagnostic différentiel dans les lésions de la région droite supérieure de l'abdomen est excessivement difficile à cause du nombre d'organes importants de cette région. Il s'ensuit que toute méthode connue doit être employée dans l'exploration des cas difficiles; ceci implique l'usage de la pyélographie, entre autres.

Pour distinguer des calculs du rein d'avec ceux de la vésicule biliaire la radiographie latérale et la pyélographie sont de première importance, et aucun examen n'est complet sans que l'on y ait en recours.

La raison de la difficulté dans le radiodiagnostic des calculs biliaires se trouve surtout dans la différence de la densité des calculs; voilà pourquoi on admet qu'un mouvement ayant lieu pendant l'exposition peut changer la valeur radiographique de l'épreuve négative. Les mouvements peuvent être volontaires et involontaires; parmi les derniers se trouvent les mouvements de la vésicule biliaire et de ses conduits, qui suffisent pour abîmer une bonne épreuve négative. Les mouvements des autres organes de la région comme ceux du duodénum et de l'estomac, de l'aorte etc. peuvent avoir le même effet. Il faut par conséquence insister sur la nécessité de faire l'exposition aussi courte que possible dans un travail de ce genre.

RESUMEN

El punto principal en la técnica radiológica es la rapidez de la exposición y la inmovilidad completa de la parte examinada. El caso de purga precediendo inmediatamente al examen y el momento, en que haya sidotomado el alimento, son de una gran importancia.

La composición de los cálculos biliares tiene una gran influencia en el resultado del examen radiográfico. La colestestina, cuando es pura, no presenta más que una sombra muy débil, fácilmente obscurcida por capas superpuestas, como el hígado, el riñón, etc. Resulta difícil poder mostrar un cálculo de colestestina pura por el método directo. La colestestina pura y los cálculos que contienen tan sólo una pequeña proporción de sales calcareas flotan en el agua, los que contienen mayor cantidad van al fondo. Esto da, "grosso modo", el porcentaje de los cálculos biliares susceptibles de poder ser encontrados por el método directo.

El diagnostico diferencial en las lesiones de la región derecha superior del abdomen resulta sumamente difícil a causa de los numerosos órganos superpuestos en esta región. Así se deduce que todo método conocido debe emplearse en la exploración de los casos difíciles, lo cual implica el empleo de la pyelografía, entre otros varios.

Para distinguir los cálculos del riñón de los de la vejiga biliar la radio-

grafia lateral y la pyelografia son de gran importancia, y ningún examen resulta completo sin acudir a ambos procedimientos.

La causa de la dificultad en el radiodiagnóstico de los cálculos biliares consiste sobre todo en la diferencia de la densidad de los cálculos, por lo cual se admite que cualquier movimiento durante la exposición puede modificar el valor radiográfico de la prueba negativa. Los movimientos pueden ser voluntarios e involuntarios; entre estos últimos se encuentran los movimientos de la vejiga biliar y de sus conductos, que son suficientes para estropear una buena prueba negativa. Los movimientos de otros órganos de la región, así como los del duodeno y del estómago, de la aorta, etc. pueden tener el mismo resultado. Por consiguiente, es necesario insistir en la conveniencia de hacer la exposición tan corta como posible en los trabajos de este género.





Fig. 6.



Fig. 7.



Fig. 8.

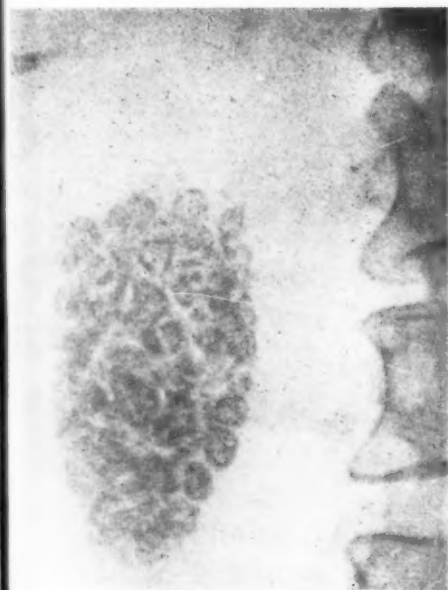


Fig. 9.



Fig. 10.

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Fig. 11.



Fig. 12.



Fig. 13.



Fig. 14.

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Fig. 15.



Fig. 16.



Fig. 17.

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Fig. 18.



Fig. 19.

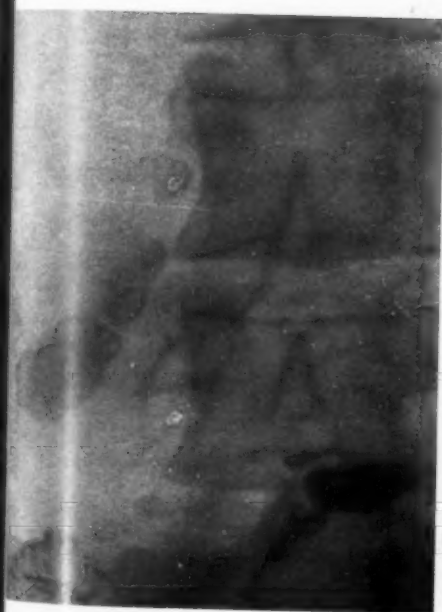


Fig. 20.



Fig. 21.

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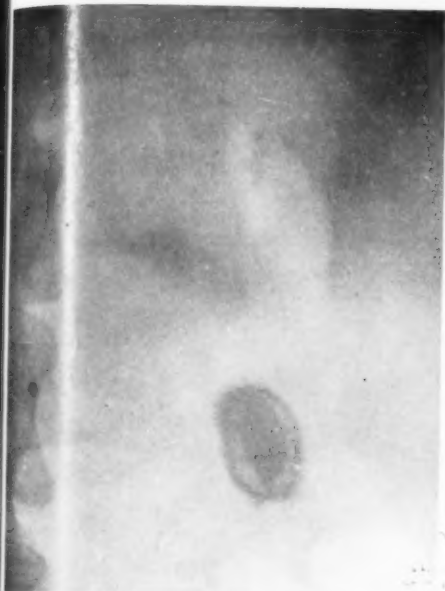


Fig. 22.



Fig. 23.

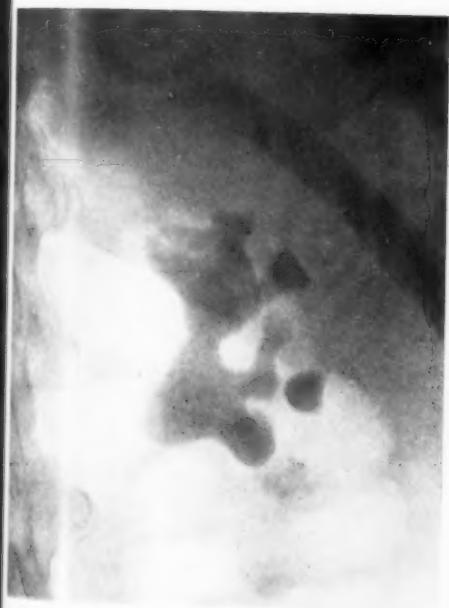


Fig. 24.



Fig. 25.

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ANNULAR SHADOWS IN THE ROENTGEN PICTURE AS INDICATIONS OF LOCALIZED PNEUMOTHORAX

by

P. Flemming Møller and G. E. Permin

Of late, the so-called "localized pneumothorax" has been the subject of considerable discussion, and the new ideas that have thus come to light regarding its prevalence, the various modes of its origin, and the possibility of its diagnosis, are of the greatest interest to phtisiologists and roentgenologists alike.

In the older literature the opinion prevails that a pneumothorax but rarely occurs as a complication of pulmonary tuberculosis (the proportion being about 2 per cent only). When a spontaneous pneumothorax was spoken of, there was usually meant, by that expression, a total one; while a "partial pneumothorax" nearly always signified a relatively extensive one. We will not here go into the details of the physical examination, but will only say that roentgen examination of the lungs not unfrequently discloses changes, which in the opinion of the examiner must be interpreted as cavities — and which formerly, at least, were interpreted as such — while the physical examination does not reveal signs of any cavity.

That there exist what the French call "cavernes muettes" is quite beyond doubt. CHAOUŁ and STIERLIN even state that the very minutest clinical examination not unfrequently fails to disclose caverns in cases, in which they are actually present, and would seek the explanation of such failure either in a too deep situation of the cavity or in its being filled with some liquid fluid and for that reason impossible to differentiate from the infiltrated lung tissue. Nevertheless, the roentgen picture sometimes shows cavities — or what would appear to be cavities — of such dimensions that it is astonishing they do not produce physical symptoms. And it is in these cases the question arises, whether we are really face to face with caverns or not.

If this question of the small partial pneumothorax has lately become so burning, it is due to the examination of certain changes which have been described as annular shadows on account of the ring-shaped, dense shadow observed to surround the bright area. SAMPTON, HEISE and BROWN were the first who believed themselves able to demonstrate that these annular formations were due, not to pulmonary changes but to a localized pneumothorax. It is true that even before the publication of the paper by the authors just named, GAILLARD, SABOURIN and FISHBERG had stated that the partial pneumothorax was of more frequent occurrence than had hitherto been supposed, and far more prevalent than the total one; but it is chiefly *following* the paper of the first-named investigators that contributions, particularly American ones, have appeared trying to establish as a fact that a small, localized pneumothorax is an extremely common occurrence in the progress of a pulmonary tuberculosis, and that a pneumothorax of this kind does by no means always produce an annular shadow. BARLOW and THOMPSON, particularly, try to prove this, on the basis of a very extensive material, in a large dissertation published in Washington, in 1922. As the result of their investigations these two authors believe themselves justified in asserting that in cases, in which the development of tuberculous lesions is taking place in the lungs, the occurrence of small, partial pneumothoraces all through the affected parts is the rule and not an exception. The small pneumothoraces are so common that nearly every case of tuberculosis shows one or more of them at one stage of the disease or another, and they can be distinguished, according to their location, into lateral, central, medial, interlobar, etc., pneumothoraces. The material of BARLOW and THOMPSON comprised 525 cases of pulmonary tuberculosis. Small pneumothoraces were present in 64 per cent of these, while in a material of 473 non-tuberculous cases pneumothorax was only found in 2 instances, one of these being, moreover, a patient suffering from an abscess of the lung, and the other a case of empyema. From this, the authors believe themselves justified in concluding that the presence of small pneumothoraces may be taken as a positive diagnostic indication of tuberculosis.

To diagnose a pneumothorax it is necessary that one should be able to observe a separation of the pleural surfaces; but in an ordinary roentgenogram of the thorax such a separation can only be seen, if it is large enough to embrace the entire apex, or if it reaches all the way from the anterior to the posterior axillary fold, that is: if it produces a space entirely clear of any lung markings. The very small pneumothoraces can only be observed in a stereoscopic roentgenogram of the lung, and even there it requires

considerable practice to detect them, though, when once this practice is acquired, it is said to be a very easy matter. In the ordinary picture the part of the lung where the pneumothorax is located will give just as much shadow as the rest of the lung, because in most cases the small pneumothorax will be covered by lung tissue, and because the collapse of the lung which unavoidably accompanies a pneumothorax of this kind will lie either toward the observer or away from him.

Usually when examining a pneumothorax one is accustomed to seeing it represented by an absolutely clear space, and the existence, in a zone of undiminished density, of a cavity covered by the shadow of the lung does not immediately suggest itself. But inasmuch as the small pneumothoraces usually occur above the portions of the lung that are most highly infiltrated, the density is often more pronounced over the pneumothorax than over the rest of the lung, and in this fact lies one of the chief difficulties, for the unpractised eye, of detecting the small pneumothoraces.

Finally, it is stated by BARLOW and THOMPSON that annular shadows may be indications of a local pneumothorax. These annular shadows consist in homogenous bands of greater or lesser width, and form a more or less circular figure, either completely closed or nearly so. They can be much larger than cavities, and their inner edge is sharply defined, while the outer one is more or less indistinct. These annular shadows are highly interesting, and there is a great diversity of opinion as to the manner in which they should be interpreted. There is no doubt but that they can be either pulmonary or pleural, and, according to BARLOW and THOMPSON, it should be possible to determine by means of stereoscopic roentgenography, whether they are of the former kind or of the latter.

As regards the general clinical symptoms of small pneumothoraces, a perusal of BARLOW and THOMPSON's article does not suggest any really new and absolutely reliable means of distinguishing between the cavern and the pneumothorax, though these authors hold that a certain amount of practice will enable the observer, in most cases, to make a correct diagnosis on the basis of the results of the physical examination. Only in the case of small pneumothoraces is it impossible to determine their localisation and extent by physical examination alone. The importance ascribed to the various physical phenomena, singly taken, should probably be viewed with a very critical eye, because it is stated that all the stethoscopic indications of a cavity in the lung can be present in pneumothorax as well, which makes it a matter of uncertainty whether, from the signs present, the one or the other diagnosis of the two ought to be made.

The Scandinavian literature includes an excellent treatise, by HELGE DAHLSTEDT, on localized pneumothorax in pulmonary tuberculosis (Beitr. zur Klin. d. Tub., Bd. 52). In that contribution the author mentions a number of cases in which the roentgen picture showed annular shadows although there were no clinical indications of any cavity; the annular shadows disappearing after a while and being interpreted by the author — no doubt correctly — as small partial pneumothoraces. This is probably the first communication, except those from America, dealing with this problem.

At the *Frederiksberg Hospital* we have already for a considerable time been greatly interested in this question of the localized pneumothorax. As much as two and a half years ago, and without our being at that time acquainted with any of the literature on the subject, it became clear to us that not all the changes observed in the roentgen picture and described as caverns were really of that nature, but that some of them were possibly due to small pneumothoraces. What originally made us to take up the question was a case in which an annular formation which was revealed by the roentgen picture in the upper part of one of the lungs, and which we had diagnosed: cavern, disappeared within a rather short time. Since then we have observed a number of cases, in which annular shadows have been present; but although we have undoubtedly acquired a certain amount of experience in forming an opinion as to their nature by comparing the roentgen picture with the clinical findings, still we have not yet succeeded in making the correct diagnosis in every single case. We have for some time pursued our investigations by means of stereoscopic roentgenography, and although we have not yet obtained any positive result, we are hoping that this manner of proceeding may eventually help us to come to a definite solution of the problem. The conditions forming the subject of these investigations are rather complicated, and absolute accuracy of judgment can undoubtedly only be acquired as the result of considerable practice and abundant material.

The following is a brief synopsis of some cases observed by us, in which the annular shadows found in the roentgen picture would seem to indicate a localized pneumothorax.

Case I. Mr. C. — For a year past, the patient has been feeling tired and indisposed and has been coughing a good deal. Six months ago he was in bed for 7 weeks, with fever, much coughing and expectoration. At the time of his admission there was a slight amount of yellowish sputum with positive finding of tubercle bacilli which very soon disappeared entirely; only in the beginning was there a slight rise of temperature. He recovered quickly and his general condition became quite satisfactory. Stethoscopic

examination showed dullness of the second degree over left apex down to the second rib and halfway down the scapula respectively; in that locality, faint bronchial respiration and moderate number of fine râles following coughing. In the right side there were only insignificant changes.

Roentgen examination, Sept. 28, 1921 (see Fig. 1): The roentgenogram of the thorax shows the entire left lung to be the seat of unequally large infiltrations, being densest in the centre of the pulmonary area and here apparently originating from the enlarged and spotted glands of the hilus.



Fig. 1.



Fig. 2.

The right side, too, is affected in the same manner, though not as strongly. Here, also, the glands of the hilus are considerably enlarged and spotted.

Upwards and outwards underneath the clavicle there is a circular patch the size of a penny, surrounded by a denser area (annular shadow).

Febr. 28, 1923 (Fig. 2): The roentgenogram of the thorax shows that the annular shadow underneath the clavicle, mentioned above, has now entirely disappeared. Its location in the picture of the lung is now marked only by a sort of slightly shrivelled and marbled appearance. Otherwise the scattered infiltrations both in the right and — particularly — in the left lung are unchanged as on Sept. 28, 1921, when the first examination took place.

Case II. Miss F. — Had a brief attack of the grippe 3 months ago. Since that time there had been a certain amount of coughing accompanied by some expectoration in the morning; she had been feeling tired and indisposed, had been sweating at night and had lost weight not a little. Only for a few days had her temperature been above the normal. *During the last few days she had had a strong burning sensation and sharp stitch in the right side of the chest.* At the hospital she coughed but little, and only a limited number of bacilli were found in her sputum. The stethoscopic ex-

amination showed a dullness of the second degree over right apex down to the second rib, good spina, weak respiration and only a very few râles following coughing.

Roentgen examination, Jan. 7, 1922 (Fig. 3): A roentgenogram of the thorax shows the linear markings of the left lung to be natural, while on the right side they are somewhat coarser and faintly studded from the hilus upwards toward the apex, undoubtedly as the result of slight peribronchial changes and slight infiltrations in this locality. Furthermore there is seen, between the 3rd and the 5th ribs, at the back and rather medial, an almost circular light area about $3\frac{1}{2}$ cm. in diameter, surrounded by a somewhat

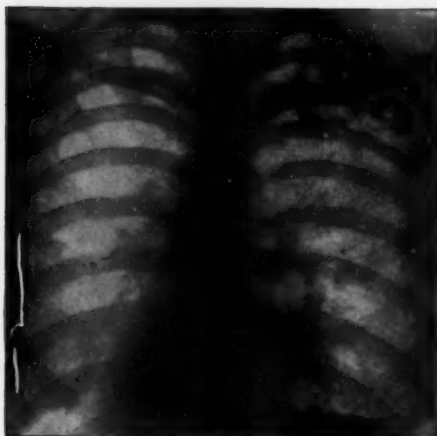


Fig. 3.

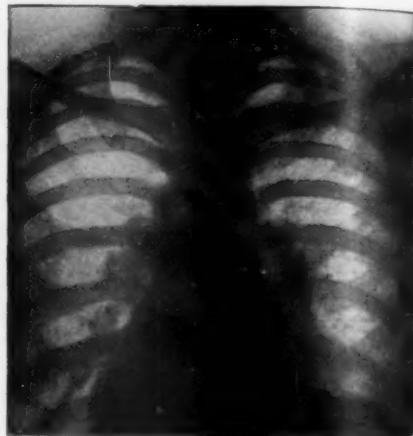


Fig. 4.

denser zone, and in the upper part of the lung, some calcifications, each of them the size of a pea.

March 3, 1922 (Fig. 4): A roentgenogram of the thorax shows that the above-mentioned light area in the right apex has disappeared. There are now more pronounced, spotted infiltrations just above and below the clavicle, and altogether the right lung seems to present a more deteriorated appearance than when last examined. The density in the direction of the hilus is more extensive, and there are probably scattered infiltrations all through the lung. On the left side there is nothing positively abnormal to be observed, with the exception of the calcifications in the glands of the hilus.

Case III. Mr. J. — For some months the patient has been coughing somewhat, with viscid sputum; for some days his temperature has been above the normal. He has been feeling quite strong, but has perhaps grown a little thin. During the last few days he has felt a stitch in the left side. By the stethoscope, crepitations were heard on both sides, and in the right infrascapular region some rhonchi and rather undefined râles. At the same time there were signs indicating a distinct emphysema. The patient was sent

to the sanatorium at Søllerød and, on being examined there, was found + bac. tub. He made a good recovery, and altogether there was only slight expectoration.

The roentgen examination (Fig. 5) of the right lung showed toward the lateral side a large annular shadow surrounded by a zone of very great density, and furthermore, in the base of the lung, densely studded, marbled, linear markings, which undoubtedly represented infiltrations.

A roentgen examination 6 months later (Fig. 6) showed the annular shadow to have completely disappeared, and the dense area to have become lighter.



Fig. 5.

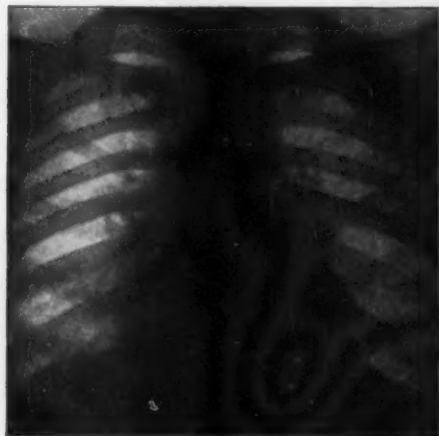


Fig. 6.

Case IV. Mrs P. — This patient had already on a previous occasion been treated, both here and at the Nakkebølle Sanatorium, for a bilateral phthisis of considerable extent. When brought in a second time, she stated that since her previous discharge she had been feeling quite well up to about two weeks ago, when she had a spell of high fever. This was of brief duration, however, and had abated almost completely at the time of her re-admission. For some days she had had a sensation of burning in the left side. At first, there were about 20 or 30 sputa daily, with positive finding of tubercle bacilli. The expectoration soon became less. The stethoscopic examination showed, for the left lung: dullness of the second degree with faint bronchial respiration and fine râles all through; for the right lung: changes similar to those in the upper half of the left. The patient made a rapid and good recovery.

June 21, 1923. The roentgen examination of the lungs (Fig. 7) shows on the left side, in an upward and lateral direction, an annular shadow about $3\frac{1}{2}$ cm. in diameter, circumscribed by a rather dense but irregular zone. Within the area thus circumscribed the lung tissue is less distinctly pronounced than in the surrounding zone. In its lower part there is a water

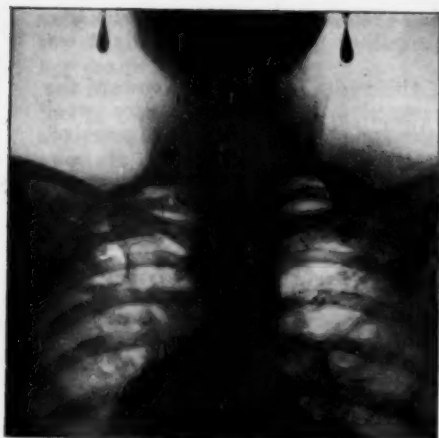


Fig. 7.



Fig. 8.



Fig. 9.

level. Altogether, the linear markings of both lungs is very coarse and well-defined, and at the left apex they are studded.

June 27, 1923. Renewed examination of the lungs, particularly for a possible water level in the cavity already noticed in the upper part of the left lung, shows the undoubted presence of a liquid: the shadow of its level remaining horizontal even when the patient bends over side-ways. Also on the right side there is an annular shadow in the centre of the lung.

Aug. 4, 1923. A roentgenogram of the thorax (Fig. 8) shows the annular shadow below the clavicle to have become very much smaller. Instead of

3½ cm. it now only measures 2½ cm. in diameter, and there is no longer any liquid to be seen at the bottom of the light area. Otherwise the picture is unchanged.

Aug. 10, 1923. A roentgenogram of the thorax (Fig. 9) shows the annular shadow below the left clavicle to have increased considerably in size since the previous examination (Aug. 4), when its dimensions were found to be very much smaller than when it was first observed (June 21). It is now 3.2 by 4.5 cm. There is no water level. The annular shadow in the right lung is likewise somewhat larger than when last observed, and now shows a distinct water level.

SUMMARY. The authors have described 3 cases of pulmonar tuberculosis, in which the roentgen pictures showed marked annular shadows, though the stethoscopic and every other clinical examination failed to reveal the presence of any cavity, and in which a roentgen examination made at a later date showed the annular shadow to have disappeared. From the evidence at hand they believe that in these cases there could not, as a matter of fact, be any cavities. They can therefore only explain these small annular formations as cases of localized pneumothorax which have disappeared afterwards; and as regards these 3 cases they thus agree with the authors just mentioned. In the 4th of the cases described above, the annular shadow persisted, but its size varied markedly from one time to another, and there were no unfailing signs of any cavity. Also in this case the authors believe a localized pneumothorax to be the most probable explanation.

ZUSAMMENFASSUNG. Die Verff. beschreiben 3 Fälle von Lungentuberkulose, bei welchen die Röntgenbilder ausgesprochene ringförmige Schatten zeigten, obzwar Auskultation und alle anderen klinischen Untersuchungen jedes Anzeichen des Vorhandenseins einer Kaverne vermissen liessen. Eine späterhin wiederholte Röntgenuntersuchung zeigte, dass der annuläre Schatten inzwischen verschwunden war. Nach dem vorliegenden Befund glauben sie, dass es sich bei diesen Fällen tatsächlich nicht um Kavernen handeln konnte. Sie können sich diese kleinen ringförmigen Formationen deshalb nur als Fälle von lokalisiertem Pneumothorax erklären, der später verschwand und stimmen also betreffs ihrer 3 Fälle mit der Deutung der von ihnen zitierten Autoren überein. Im vierten hier beschriebenen Fall blieb der ringförmige Schatten bestehen, aber seine Grösse variierte merklich von einem Mal zum anderen und es fanden sich keine sicheren Anzeichen für eine Kaverne. Auch in diesem Fall halten die Verff. die Annahme eines lokalisierten Pneumothorax für die wahrscheinlichste Erklärung.

RÉSUMÉ. Les auteurs décrivent trois cas de tuberculose pulmonaire où les radiographies présentaient des ombres annulaires très nettes quoique l'examen stéthoscopique et toute autre méthode d'exploration clinique ne révélât aucune cavité et où l'examen radiographique opéré à une date plus avancée ne présentait plus aucune ombre annulaire. En se basant sur ces faits ils sont d'avis que dans les cas en question il ne pouvait pas réellement y avoir de cavités. Ils ne peuvent donc expliquer ces petites formations annulaires que comme des cas de pneumothorax localisé disparu ultérieurement; et autant qu'il s'agit de ces trois cas ils sont donc d'accord avec les auteurs mentionnés plus haut. Dans le quatrième cas décrit ci-dessus l'ombre annulaire persistait, mais ses dimensions variaient de temps à autre d'une façon très

prononcée et il n'y avait pas de signes indiscutable indiquant la présence d'une cavité. Dans ce cas aussi les auteurs considèrent le pneumothorax localisé comme l'explication la plus vraisemblable.

RESUMEN. Los autores describen tres casos de tuberculosis pulmonar en las cuales las radiografías presentan sombras anulares muy limpidas, si bien el examen stetoscópico y todo otro método de exploración clínica no revelaron cavidad alguna, y en las cuales, el examen radiográfico efectuado en una época más avanzada no presentaba ninguna sombra anular. Básandose en estos hechos son de la opinión que en estos casos en cuestión no podían en verdad presentar cavidades. No pueden explicar estas pequeñas formaciones anulares, que como en los casos de pneumothorax localizado, desaparecieron posteriormente; y por lo que se refiere a estos tres casos están de acuerdo con los autores mencionados más arriba. En el cuarto caso descrito anteriormente, la sombra anular persistía, pero sus dimensiones variaron de un tiempo a otro, de una manera muy pronunciada y no existían señales indiscutibles indicando la presencia de una cavidad. En este caso, los autores consideran también el pneumothorax localizado como una explicación más aceptable.

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DIE MEDIASTINO-INTERLOBÄRE PLEURITIS — EIN HÄUFIGES VORKOMMEN BEI DER MEDIASTINAL- DRÜSENTUBERKULOSE

VON

Felix Fleischner

Die tuberkulöse Affektion der mediastinalen Lymphknoten ist bekanntlich eine häufige Erkrankung im Kindesalter. RANKE hat gezeigt, dass bei jeder pulmonalen Ersterkrankung an Tuberkulose die für den befallenen Lungenabschnitt regionären Lymphknoten zwangsläufig mitbetroffen werden. RANKE und GHON fanden, dass der Infektionsprozess aber keineswegs an der ersten Lymphknotenstation Halt machen muss, sondern oft, ja in der überwiegenden Zahl der Fälle auf dem Wege der mediastinalen Lymphbahnen weitere Knoten befällt. Dieses Umsichgreifen des Prozesses kann in unmittelbarem Anschluss an die Erstinfektion erfolgen, es kann aber auch nach längerem Stillstand einsetzen, wenn der Krankheitsprozess neu aufflackert. Bekanntlich begleiten z. B. Veränderungen der mediastinalen Lymphknoten, von akuter Entzündung bis zur Verkäsung, mit grosser Regelmässigkeit die hämatogene Tuberkulose, sei es, dass diese als akute allgemeine Miliartuberkulose oder unter dem Bilde spärlicherer Aussaaten in Erscheinung tritt. Die örtliche Diagnose der Tuberkulose der mediastinalen Lymphdrüsen gründet sich im Einzelfall auf mehrere, allgemein bekannte Symptome und Untersuchungsmethoden, die paravertebrale Dämpfung nach KRÄMER die Spinalgie (PETRUSCHKY), die Perkussion der Wirbeldorne (DE LA CAMP), die Auskultation der Flüsterstimme (D'ESPINE) u. s. w. und schliesslich leistet auch die Röntgenuntersuchung dabei gute Dienste. In charakteristischer Weise findet man da dem Mittelschatten angelagerte, weichteildichte Schatten, die gegen das helle Lungenfeld scharf, einfach bogig oder polyzyklisch abgegrenzt erscheinen. Sie liegen in der Hilusgegend oder als paratracheale Drüsen weiter aufwärts und gelangen rechts häufiger zur Darstellung. Es liegt im Wesen der Sache, dass das Röntgenverfahren in vielen Fällen im Stiche

lassen wird, dann nämlich, wenn nur die mehr zentral gelegenen, mediastinalen Lymphknoten verändert sind, und sich nur dann bewähren wird, wenn auch die bronchopulmonalen und paratrachealen Drüsen erheblich vergrößert sind. Ich möchte noch hinzufügen, dass eine in querer oder schräger Durchsicht erkennbare namhafte Verdunklung des hinteren Mediastinums in Bifurkationshöhe in vielen Fällen mit grosser Wahrscheinlichkeit für eine Vergrößerung der dort gelegenen Drüsenpakete spricht. Es bedarf kaum der Erwähnung, dass eine Vergrößerung der mediastinalen Lymphdrüsen ausser bei Tuberkulose auch bei Pneumonie, Pertussis, Leukämie, Lymphogranulom u. s. w. vorkommt, doch schmälert diese Einschränkung den Wert des positiven Röntgenbefundes im Rahmen einer allgemeinen klinischen Untersuchung nicht wesentlich. Anders steht es mit dem vielfach in gleicher Weise gewerteten, vergrößerten und verdichteten Hilusschatten. Wohl können sich in einem solchen Drüsenumoren verbergen; er kann aber so mannigfacher Entstehung sein (ASSMANN, ULRICI, TENDELOO, GRÄF und KÜPFERLE), dass seine Wertung als Zeichen einer mediastinalen Lymphdrüsentuberkulose abgelehnt werden muss.

Während der letzten Jahre habe ich bei der Röntgenuntersuchung von Kindern ein Symptom kennen gelernt, das trotz des Fehlens der oben geschilderten markanten Zeichen von Lymphdrüsenvergrößerung doch mit Sicherheit die Diagnose einer akuten Erkrankung der mediastinalen Lymphdrüsen zu stellen erlaubt und das gleichzeitig eine bisher unbekannte Verlaufsform oder Begleiterscheinung der Mediastinaldrüsentuberkulose enthüllt hat.

Da ich mich dabei einer besonderen Untersuchungstechnik bedient habe, soll darüber kurz berichtet werden.

Es ist allgemein üblich, die röntgenologische Lungenuntersuchung, Durchleuchtung und Photographie bei sagittalem Strahlengang, meist dorsoventral, gelegentlich auch ventrodorsal, vorzunehmen. Wie ich an anderer Stelle ausgeführt habe,¹ bieten aber quere und schräge Durchleuchtungsrichtungen grosse Vorteile, ja vielfach die einzige Möglichkeit für die Lokalisation umschriebener Schatten, für die Erkennung lappenbegrenzter Verdichtungsprozesse und aller pathologischen Vorgänge an den interlobären Pleuren. Ich pflege daher jeden Patienten während der Durchleuchtung rundum zu drehen und suche dabei durch Höher- und Tieferführen der Röhre die Gegend der Lappenspalte ab. Auf diese Weise können Prozesse an der Pleura des grossen, schrägen Lappenspaltes oft eindeutig erkannt werden.

¹ Lobäre und interlobäre Lungenprozesse, Fortschritte a. d. G. d. Röntgenstrahlen, B XXX h. 4—6.

Mitunter beeinträchtigt der Herzschatten die Durchsicht oder die Form des interlobären Exsudates selbst vermindert die Ergiebigkeit dieses Verfahrens. Da ich die alte Anweisung von BÉCLÈRE und HOLZKNECHT zum Absuchen des grossen, schrägen Lappenspaltes: »Röhre hinten oben, beobachtendes Auge vorn unten« wegen der jetzt allgemein eingeführten zwangsläufigen Führung der Röhrenkästchen mit fixer Blende nicht befolgen kann, lasse ich den Patienten eine bestimmte Stellung einnehmen. Er lehnt sich mit dem Nacken und den Schultern fest an die Durchleuchtungswand und, während er sich mit beiden Händen an der Wand oder ihren Holmen stützt, streckt er den Bauch vor. In dieser »Kreuzhohlstellung« nähert sich die Verlaufsrichtung der grossen, schrägen Interlobärspalte der Horizontalen und es ist nun ein Leichtes, sie mittels Durchleuchtung zu inspizieren. Und so wie ich auch in schräger und querer Durchsicht nie »blind« photographiere, so suche ich auch in dieser Stellung durch Verschiebung der Röhre und geringe Aenderungen in der Haltung des Patienten bei Durchleuchtung die für meinen Zweck (scharfe Grenzen zu erhalten) geeignete Stellung auf und schliesse die Photographie an.

Ich führe einige Krankengeschichten und Röntgenbefunde an.

Beobachtung 1: Blanka M. 12 Jahre. 1. Spitalsaufnahme. Mai 1921. Anamnese: Vater hat Knochentuberkulose. Das Kind hatte mit sechs Jahren Masern. Jetzt mit Husten, Fieber, Erbrechen, Dyspnoe erkrankt, Kollaps. Befund 11. V. 1921: 147 cm langes Kind, mässig gut genährt, blass, Thorax flach. Fossae supraclavic. eingesunken. Leicht zyanotische Lippen. Auskultation: Links hinten unten trockenes Rasseln. Rechte Spitze inspiratorisch trockenes Rasseln, hauchendes Exspirium. Auch abwärts überall etwas trockenes Rasseln. Links vorn oben verschärftes Atmen, rechts etwas Rasseln. Perkussion: Ueberall heller Schall. Spitzenfelder rechts und links gleich weit. Rechts vorn Verkürzung der Fossa supraclavicularis. Verschieblichkeit des unteren Lungenrandes beiderseits etwas eingeschränkt. Zweiter Palmonalton akzentuiert. Sonst normaler Befund. Nacht ruhig, Husten, Auswurf. Geringer Nachtschweiss. — Röntgendurchleuchtung 9. VI. 1921: Hilusschatten beiderseits vermehrt, rechts mehr fleckig und strangförmig, links mehr kompakt flächig. Links basal Pleuraadhäsion. Im rechten Spitzenfeld zwei eben erkennbare, zarteste (junge) Herdschatten. — (Keine Diagnose). Subfebrile Temperaturen, abends bis 37.5. Im Sputum Koch-Bazillen negativ. — 26. VI. Rasseln bedeutend geringer, keine Dämpfung. — 8. VIII. Gebessert entlassen. (Klinische Diagnose: Apicitis(?)) — Seit der Spitalentlassung allabendlich Fieber, Nachtschweiss. In den letzten zwei Wochen ist der trockene Husten, der früher nur hie und da auftrat, heftiger. Gewichtsabnahme.

Neuerliche Spitalsaufnahme: Klinischer Befund. 9. V. 1922. Lippen etwas zyanotisch. Pirquet positiv. — Lunge: Ueber der ganzen linken Seite hinten grobes, zähes Rasseln, über dem Schulterblatt ist es feuchter, nicht konsonierend; rechts ebenso wie links vorn; links an der Spitze der Schall wenig kürzer als rechts, sents überall heller Klopfeschall. Lungenrand rechts

weniger verschieblich als links. Sonst normale Befunde. — 11. V. 1922. Das Kind hustet pertussisähnlich.

Röntgenbefund vom 11. V. 1922: Links am Mittelschatten, in der Höhe der Pulmonalis eine scharf begrenzte Vorwölbung, aber nicht nach vorne gelegen, also nicht wie Conus oder Arteria pulmonalis, mit grösster Wahrscheinlichkeit ein Drüsentumor. Beide Hilusschatten reichlich vergrössert und verdichtet, links mehr als rechts. Von ihnen strahlen mässig dichte, harte Stränge allseitig aus. Links von Mittelhöhe abwärts zarteste, eben merkliche Verschleierung des Feldes. Bei Seitendurchsicht wird ein weichteildichter, bandförmiger, beiderseits (in verschiedenen Stellungen) scharf begrenzter Schatten entsprechend dem unteren Teil des Lappenspaltes sichtbar. In dorso-ventraler Durchsicht, Röhrenhochstand und maximaler Dorsalneigung der Pat. (Kreuzhohlstellung) erscheint ein oben und unten scharf linig begrenzter Dreiecksschatten links an den Herzschatten angelagert. Die Bewegung des linken Zwerchfells ist eingeschränkt. Zusammenfassung: Abgesackter Pleuraerguss links mediastinal und interlobär; vergrösserte mediastinale Drüsen(?). Betrachtet man das dorso-ventrale Bild (Abb. 1 a), so könnte man leicht einen Befund erheben, der dem erstangeführten vom 9. VI. 1921 sehr nahe kommt; bevor ich gelernt habe, jeden Thorax allseitig zu untersuchen, gleichgiltig: ob irgend etwas auf einen lobären oder interlobären Prozess hinweist oder nicht, hätte gewiss auch ich die Untersuchung damit abgeschlossen und den Befund in gleicher Weise abgefasst. Bei der Seitendurchsicht leuchtete aber sofort, entsprechend dem unteren Teil des schrägen Lappenspaltes links eine scharfe, linige Grenze auf, die ein dunkles Feld vorn oben von einem hellen hinten unten schied (am deutlichsten, wenn ich die Pat. aus dem Rechts-Links-Querdurchmesser ein wenig gegen den zweiten schrägen Durchmesser drehte). Damit stand fest, dass eine lappenmässige Verdichtung des Oberlappens (seines hinteren unteren Teiles) oder ein interlobärer Erguss im unteren Teil des Lappenspaltes vorliegen müsse. Eine Entscheidung konnte ich treffen, indem ich die Pat. aus dem frontalen ein wenig gegen den verkehrten ersten schrägen Durchmesser drehte. Die Lichtverhältnisse sind bei dieser Projektion wegen des breiten Herzschattens sehr ungünstig. Gleichwohl gelang es, bei Durchleuchtung und auf der Platte eine geradlinig scharfe, mit der früheren annähernd parallele vordere obere Schattengrenze festzustellen.

Die so ermittelte Diagnose eines interlobären Ergusses erfuhr eine Bestätigung und Erweiterung durch die Untersuchung in Kreuzhohlstellung, die ich in Erinnerung an die alte Anweisung von BECLÈRE und HOLZKNECHT durchführte. Da laufen die Strahlen von hinten oben nach vorn unten, also in der Längsrichtung des Lappenspaltes. Bei einem rein interlobären Erguss muss ein Schatten von der Querschnittsform einer Linse zustande kommen. Wie das Röntgenogramm zeigt, sass der dreieckige Schatten breitbasig dem Herzschatten auf, entsprach also einem interlobär mediastinalen Erguss. (Abb. 1 b).

Es sei hier noch der Röntgenbefund mit dem Krankheitsverlauf zusammengehalten. Das familiär tuberkulosebelastete Kind erkrankt plötzlich mit Fieber, Husten, Dyspnoe. Der unbestimmte geringe physikalische Befund verhindert die Diagnose einer Pleuritis. Erbrechen weist auf Mitbeteiligung der Pleura diaphragmatica hin. Seither durch fast ein Jahr subfebrile Temperaturen, trockener Husten. Verschlechterung unter den gleichen Krank-

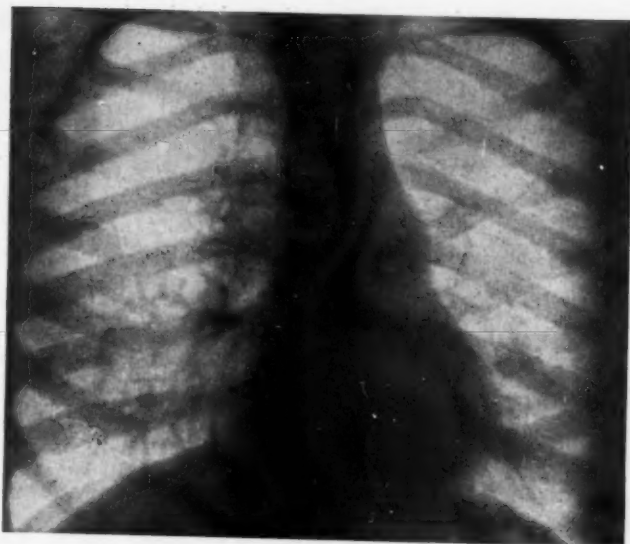


Fig. 1 a. Sagittalbild.



Fig. 1 b. In Kreuzhohlstellung.

heitserscheinungen. Der jetzige Röntgenbefund deckt eine mediastinal-interlobäre exsudative Pleuritis auf.

Weiterer Verlauf: Husten hält an, besonders bei Nacht sehr stark und anfallsweise. — 29. V. Rasselgeräusche weniger und schwächer. Die Zahl der Hustenanfälle hat sich auf 1 oder 2 bei Nacht verringert. Temperatur normal. — 10. VI. Rechts im Interskapularraum scharfes Atmen, beinahe amphorisch. Kein Rasseln. Rechts vorne Pertussis-Befund. — 26. VI. Entlassen.

Röntgenbefund 4. XII. 1923 (ambulatorisch): Hilusschatten und Lungenzeichnung wie früher. Links basal zarte Verschleierung. Der Herzrand ist klar. In Seiten- und Kreuzhohlstellung nichts Auffälliges.

Epikrise: Ein 12-jähriges Mädchen, das schon früher wegen Mediastinaldrüsentuberkulose in Spitalsbehandlung gestanden ist, erkrankt neuerdings. Die klinische Diagnose schwankt zwischen Drüsentuberkulose und Pertussis. Die Röntgenuntersuchung deckt eine exsudative Pleuritis links mediastinal-interlobär auf. Nach 1½ Jahren ist davon nichts mehr nachweisbar.

Beobachtung 2: Herta K., 8 Jahre. Aus der Krankengeschichte: Vor vier Jahren Masern, vor drei Jahren Keuchhusten und Rippenfellentzündung; seither immer kränklich, Appetit zeitweise schlecht, öfterst Fieber, keine Nachtschweisse. Seit sechs Wochen Verschlechterung des Zustandes, stärkeres Husten ohne Aufziehen, Fieber, manchmal bis 39°. Ein von anderer Seite erhobener Röntgenbefund vom 17. I. 1923 stellt leicht verdichtete Spitzenfelder fest. Der rechte Hilusschatten ist konfluierend verdichtet mit grösseren Knoten auch in seinen peripheren Teilen. Peribronchitische Ausstrahlungen nach oben und unten. Links ähnlich. Als Ergebnis wird eine besonders rechtsseitige Adenitis festgestellt. Das mir vorliegende Röntgenbild zeigt wohl vermehrte Hilusschatten, lässt aber Drüsen nicht sicher erkennen. Die darauf angesuchte Aufnahme in die Heilanstalt Grimmenstein wurde wegen Bestehens einer beiderseitigen, offenen, ausgedehnten Lungentuberkulose abgelehnt.

Aufnahme in die Abteilung POSPISCHIL am 23. II. 1923: Das Kind ist blass, schlecht genährt, leichte Schwellung der Halsdrüsen. In der rechten Axilla relative Dämpfung, links interscapular leichte Schallverkürzung, keine Spinalgie.

Auskultation: Rechts diffus trockenes Rasseln, grobes Schnurren; rechts interscapular hat das Atemgeräusch hauchenden Charakter, axillar ist es bronchial. Links oben Bronchovesikuläratmen.

Röntgenbefund vom 28. II. 1923: Beide Hilusschatten sind beträchtlich, weich, flächig-streifig vermehrt, von ihnen gehen mässig weiche Streifenschatten allseits lungenwärts, besonders reichlich nach oben. Allgemeine, spärliche Aussaat kleinster, zarter Fleckschatten. Rechts von Mittelhöhe abwärts medial ist das Feld dicht, weich, flächig verschattet. Der Schatten deckt den Herzrand. In Seitendurchsicht erscheint rechts in der Gegend der unteren Hälfte des grossen, schrägen Lappenspaltes ein etwa 1½ cm breiter, dichter Bandschatten, der nach vorne oben und hinten unten scharf geradlinig begrenzt ist. Mittel- und Unterlappenfeld sind hell. In Kreuzhohlstellung (Abb. 2 a) schiebt sich der neben dem Herzen gelegene Schatten zu

einem dichten, homogenen, scharf einfachlinig begrenzten Dreiecksschatten zusammen, der mit einer Seite dem Herzen anliegt, mit seiner Spitze fast bis zur Thoraxwand reicht. Deutung des Befundes: Haematogene tuberkulöse Aussaat mässigen Grades. *Mediastinal und interlobär zwischen Mittel- und Unterlappen abgesackter Erguss*, wahrscheinlich als Begleiterscheinung eines akuten Prozesses in den mediastinalen Lymphdrüsen.

In diesem Falle muss an die Möglichkeit gedacht werden, dass es sich um eine pneumonische Verdichtung (irgendwelcher Aetiologie) des Mittellappens handelt. Es gibt tatsächlich besonders bei Kindern ganz schmale, zungenförmige Mittellappen; wenn ein solcher Lappen verdichtet ist, scheint es trotz darauf gerichteter Aufmerksamkeit und grosser Übung mitunter unmöglich zu sein, sicher zu entscheiden, ob eine Verdichtung eines derart schmalen Mittellappens oder ein Erguss zwischen Mittel- und Unterlappen vorliegt. Hier aber sprechen das Seitenbild mit dem durch zwei parallele Linien scharf begrenzten Bandschatten und das Bild in Kreuzhohlstellung, das zeigt, dass der Schattenkörper nicht an die seitliche Thoraxwand reicht, für die angenommene Deutung.

Weiterer Krankheitsverlauf: 1. III. In der rechten Spitze und rechts interscapulär reichlich mittelblasiges, fast konsonierendes Rasseln. Später Entfieberung, Gewichtszunahme. Entlassen.

1. IX. 1923. Aufnahme in die Heilanstalt Grimmenstein:¹ Der Prozess beschränkt sich jetzt auf den Hilus, kein Husten, kein Auswurf. Röntgenbefund: Linke Spitze dunkler als rechts, fehlende Aufhellung. Das mittlere Drittel des linken Lungenfeldes homogen verschattet, rechts vermehrter Hilusschatten und vermehrte Lungenzeichnung. Röntgenbefund 8. I. 1924: Vom Hilus ausgehende, stark vermehrte fleckig-streifige Lungenzeichnung beiderseits, sonst normaler Befund. Das Kind ist vollkommen entfiebert. Auskultatorisch keine Nebengeräusche. Gewichtszunahme von 6 kg. Das Kind wird am 23. II. 1924 geheilt entlassen.

Neuerliche Röntgenuntersuchung 1. III. 1924 (Abb. 2 b.): Allgemein etwas vermehrte Streifenzeichnung, vereinzelte kleinste Fleckschatten. Beide Hilusschatten mässig vermehrt, streifig-flächig. Rechts von Mittelhöhe nach aussen unten ein gegabelter Strichschatten (Pleuraleiste). Links der Herzkontur an der Spitze unklar, ein Zipfel und ein Streifen lungenwärts. Im Seitenbild und in Kreuzhohlstellung kein auffälliger Befund. Deutung: Der früher gesehene Schattenkörper rechts ist verschwunden. Rechts interlobäre, links interlobär-mediastinale Pleuraschwarten.

Epikrise: Bei dem achtjährigen Kind tritt während eines akuten Nachschubes der Bronchialdrüsentuberkulose mit mässiggradiger Aussaat ein grosses, mediastinal-interlobäres Exsudat rechts zwischen Mittel- und Unterlappen auf. Der auf Grund allgemeiner klinischer Untersuchung prognostisch sehr ungünstig beurteilte Krankheitszustand geht in Heilung aus. Nach einem Jahr sind röntgenologisch neben den Resten der älteren Aussaat nur zarte interlobäre Pleuraschwarten nachweisbar.

¹ Für die freundliche Überlassung der Krankengeschichte bin ich Herrn Prim Dr Maendl zu Dank verpflichtet.



Fig. 2 a. In Kreuzhohlstellung.



Fig. 2 b. Nach 1 Jahr.

Beobachtung 3: Therese M., 7 Jahre. Aus der Anamnese: Normal entwickeltes Kind. Masern, Keuchhusten, viermal Lungenentzündung und Rippenfellentzündung. Vor zwei Jahren nach Lungen- und Rippenfellentzündung durch vier Monate in Anstaltsbehandlung (Aufgelassen, Krankengeschichte nicht erhältlich). Seither bei schlechter Witterung trockener Husten und Atemnot. Im letzten Jahr mehrmals wegen Husten bettlägerig. — Am 6. III. 1923 hohes Fieber, Husten, Stechen auf der Brust, Nachtschweisse, Appetit gering, Stuhl in Ordnung; Gewichtsabnahme. Alle Geschwister wegen Lungenleiden in Behandlung.

Aus dem Status praesens. 10. III. 1923. Schlechter Ernährungszustand, Muskel und Haut schlaff, Haut blass, Lippen leicht zyanotisch; in der Nacht ruhig, etwas Husten. Klagen über Schmerzen auf der Brust beiderseits. Kleine Drüsen rechts und links am Hals und in den Achselhöhlen. Ueber beiden Spitzen trockene, grobe Rasselgeräusche, and der Basis grobes, krepitierendes Rasseln bei abgeschwächtem Atemgeräusch. Rechts subapical amphorischer Beiklang (Trachea?). Der im übrigen helle Perkussionsschall zeigt über dem unteren Drittel der Scapula links etwas Schachtelton, ebenso auch interskapular rechts. Die Lungenränder sind schlecht verschieblich. Herz in normalen Grenzen u. s. w. Klinische Diagnose: Bronchialdrüsentuberkulose.

Röntgenbefund 15. III. 1923 (Abb. 3 a): In beiden Lungenfeldern allgemein vermehrte Zeichnung, gröbere Streifenschatten, längs dieser mässig zahlreiche, gleichmässig verteilte, kleinere und grössere, dichte, harte Fleckschatten. Beide Hilusschatten vermehrt, weich, flächig, streifig. Rechts von der Mittelhöhe abwärts, medial ein inhomogener, mässig dichter Flächenschatten, der den Herzkontur vollkommen deckt, links neben der Herzspitze ein ähnlicher von geringerem Umfang. Zwerchfell, Pleurasinus frei. In querer Durchsicht zeigt sich rechts, entsprechend dem unteren Teil des grossen, schrägen Lappenspaltes, ein bandförmiger Schatten, der — in zwei verschiedenen Stellungen — das eine mal nach vorn oben, das andere mal nach hinten unten scharflinig begrenzt ist. In *Kreuzhohlstellung* (Abb. 3 b) sammelt sich der mässig dichte Flächenschatten des Sagittalbildes rechts und links zu einem dichten, homogenen, einfach linig begrenzten Dreiecksschatten, der dem Herzschatte aufsitzt und nach lateral in einen feinen Strichschatten ausläuft. Dieser Schatten ist rechts bedeutend grösser als links und pulsiert kleinwellig herzhrythmisch. Die in die klinische Diagnose aufgenommene Röntgendiagnose: Aeltere, wahrscheinlich in Schüben erfolgte, hämatogene tuberkulöse Aussaat mässigen Grades. Mediastinal und interlobär abgesackte exsudative Pleuritis, offenbar als Folge eines akuten Prozesses in den mediastinalen Lymphdrüsen. Das Kind entfieberte in wenigen Tagen; sein Befinden besserte sich subjektiv und objektiv (Gewichtszunahme) in kurzer Zeit.

Der bei einer ambulatorischen Nachuntersuchung erhobene Röntgenbefund (3. XII. 1923), Sagittalbild: Die disseminierten Fleckschatten in Art und Zahl wie früher, ebenso die Hilusschatten. Die Schatten rechts und links medial sind kleiner und weniger dicht; dies geht besonders daraus hervor, dass die früher gedeckten Konturen des Herzschatte jetzt klar sichtbar sind. In Kreuzhohlstellung findet sich an Stelle des früher Gesehenen rechts ein ganz zarter, dreieckiger, von einer zarten Linie umsäumter Flächenschatten; links ein etwas dichter, streifig inhomogener Schatten, der wie ein Sporn in den Lappenspalt reicht. Deutung: Das Exsudat ist

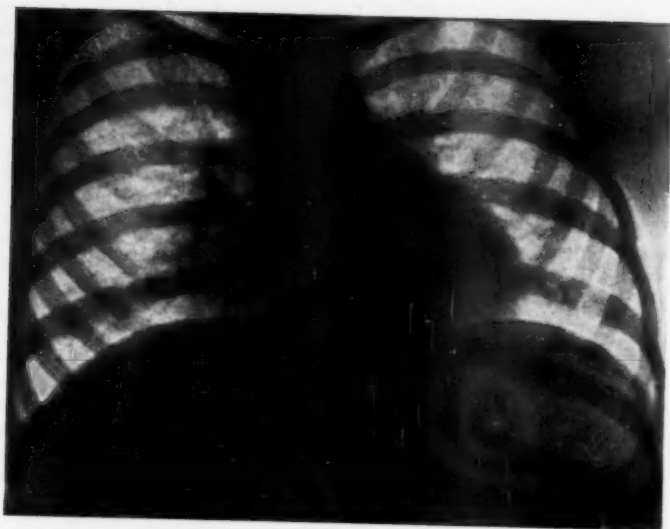


Fig. 3 a. Sagittalbild.



Fig. 3 b. Kreuzhohlstellung.

resorbiert und hat im Bereich seiner früheren Ausdehnung Pleuraschwarten hinterlassen.

Epikrise: Ein siebenjähriges Kind erfährt eine Exazerbation seiner Bronchialdrüsentuberkulose und haematogenen Lungentuberkulose. Gleichzeitig treten rechts und links im grossen, schrägen Lappenspalt Pleuraexsudate auf. Nach neun Monaten sind an deren Stelle nur Pleuraschwarten nachweisbar.

Beobachtung 4: Ida H., 12 Jahre.

Anamnese: Normale Geburt, Brustkind, gute Entwicklung. Mit sechs Jahren Masern, mit sieben Jahren Lungenentzündung. Seit mehreren Monaten Abmagerung, Husten, Müdigkeit, geringer Appetit. Jetzt seit vier Tagen krank, Atemnot, Schmerzen auf der Brust, Seitenstechen, Husten, dabei Auswurf, Fieber, Mattigkeit. — Geimpft, Wohnung licht, trocken. Vater an Typhus gestorben.

Befund vom 11. VI. 1923. Status praesens: Ziemlich gut genährtes Kind im Beginne der Entwicklung. 27.5 kg schwer, 131 cm lang. Wenig Schlaf. Sehr viel lockerer Husten. Kein Auswurf. An den Streckseiten der unteren Extremitäten zahlreiche kleine Knötchen (Prurigo). In inguine bohnergrosse Drüsen tastbar. Ganz leichte Zyanose. Pirquet stark positiv mit deutlicher Quaddelbildung.

Ueber der ganzen linken Seite der Lunge Schnurren und Rasseln zu hören. Rechts ebenfalls bis an die Basis, wo das Atmen einen unbestimmten, fast bronchialen Charakter annimmt mit feinem, krepitierendem Rasseln. Gegen die Axilla zu hört man nur beim Husten sehr dichtes, grobes Rasseln. Keine Dämpfung, die Lungengrenze ist rechts hinten unten gut verschieblich. Leberdämpfung beginnt an der 6. Rippe. Ueberall vorn ist grobes Schnurren zu hören. An der Herzspitze hört man ein weiches systolisches Geräusch, das gegen die Parasternallinie zu ziemlich laut wird. Das Geräusch ist auch an der Basis zu hören, aber weniger laut. Herzdämpfung. Linker Sternalrand etwas einwärts von der Mamillarlinie, 3. Rippe. Spitzenstoss undeutlich zu tasten. Herzpulsation in der Magengrube deutlich zu sehen. Zweiter Pulmonalton ist verstärkt, aber nicht klappend. Puls unregelmässig. Die Arterie mässig gefüllt.

Röntgenbefund 13. VI. 1923 (Abb. 4 a): Der Mittelschatten ist nach rechts verbreitert, ohne scharfe Grenze gegen das Lungenfeld. Im rechten Lungenfeld in Mittelhöhe einige grössere, mässig dichte, weiche Fleckschatten. Von der Mittelhöhe abwärts medial, den Herzrand deckend, ein wenig dichter Flächenschatten, der nach aussen und oben abklingt. Links ist das Oberfeld zart verschleiert, darin zarte, weiche Fleck- und Streifenschatten. Im linken Hilus, dessen Schatten vermehrt ist, ein scharf begrenzter, rundlicher Schattenfleck. Beide Zwerchfelle gut gerundet, die Atembewegung des rechten eingeschränkt. Das Herz ist nach links verbreitert, seine Spitze ist plump, die Taille angedeutet verstrichen. In querer Durchsicht zeigt sich rechts, entsprechend der unteren Hälfte des grossen, schrägen Lappenspalt, ein nach beiden Seiten scharf geradlinig begrenzter, dichter Bandschatten. In *Kreuzhohlstellung* (Abb. 4 b) ist rechts dem Herzen, gerade im Herz-Zwerchfellwinkel ein schmal dreieckiger oder vogelschnabelförmiger Schatten angelagert. Er ist dicht, einfach linig, scharf begrenzt und ragt lateral etwas über die Hälfte der rechten Thoraxbreite. *Zusammenfassung* des

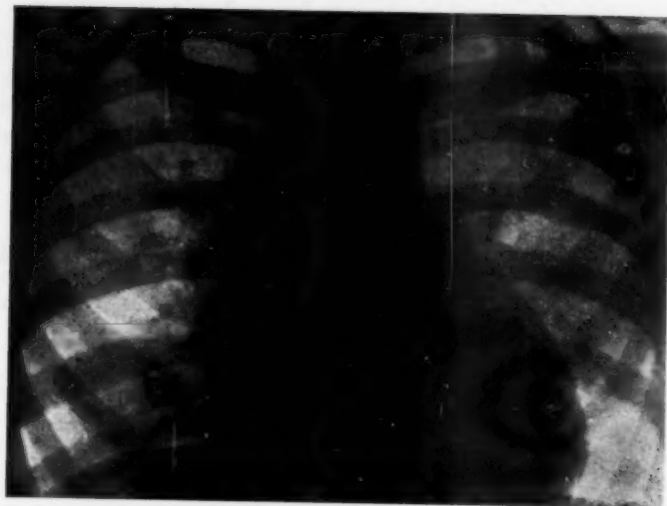


Fig. 4 a. Sagittalbild.



Fig. 4 b. In Kreuzhohlstellung.

Lungenbefundes: Die paramediastinale Verschattung rechts ist mit grosser Wahrscheinlichkeit auf paratracheale und bronchopulmonale Drüsenumoren zurückzuführen, wie links einer sicher nachzuweisen ist. Mässig dicht ausgesäte Herde, besonders im oberen Teil der linken Lunge. *Rechts Pleuraerguss mediastino-interlobär zwischen Mittel- und Unterlappen.*

20. VI. 1923. Ueber der rechten Lunge reichlich verschärftes Atmen mit trockenem Rasseln, links spärlicher. Keine Dämpfung. — 15. VII. 1923. Geheilt entlassen.

Wiederaufnahme 14. XI. 1923. Seit der Spitalsentlassung war das Kind nie beschwerdefrei. Bis vor einer Woche Schmerz in beiden Kniegelenken, häufig Schwindel, Stechen rechts im Rücken und auf der Brust. Appetit immer gering.

Befund 15. XI. 1923: Mittelgut genährt, sehr blass. Sehr stark positiver Pirquet. Mässige Struma. Ganz geringe Zyanose. Im Nacken kleine Drüsen tastbar.

Lunge: Krönig rechts eingeschränkt, hier auch kürzerer Schall als links. Von der Spina abwärts beiderseits heller Schall. Gute Verschieblichkeit der Lungengrenzen. Ueber der rechten und linken Spitze scharf vesikuläres Atmen mit verlängertem Expirium ohne Nebengeräusch. Links intraskapulär fast homogenes In- und Expirium. Sonst über beiden Lungen vesikuläres Atmen. Vorn überall heller Schall und Vesikularatmen.

Herz nach links bis einquerfingerbreit ausserhalb der Mamillarlinie, nahe bis zur Mitte des Sternum, nach oben bis zum unteren Rand der zweiten Rippe. Kein Frémissement. Ueber der Spitze kurzes praesystolisches und langes systolisches Geräusch, über der Basis ebenso laut hörbar. Zweiter Pulmonalton ziemlich betont und gespalten. Puls klein, etwas beschleunigt, regelmässig.

Abdomen: Im Thoraxniveau Leber und Milz nicht vergrössert. Ueberall tympanitischer Schall.

Diagnose: Bronchialdrüsentuberkulose. Vitium cordis (Mitralinsuffizienz, beginnende Stenose?).

Aus dem Röntgenbefund 19. XI. 1923: Die Verschattung rechts medial unten ist vollständig verschwunden. Auch in Querdurchsicht und Kreuzhohlstellung kein auffälliger Befund.

Epikrise: Bei einem 12jährigen Mädchen flackert die Tuberkulose der mediastinalen Lymphdrüsen auf. Es kommt zu einer mässiggradigen haematogenen Aussaat in die Lunge, gleichzeitig zu einer Beteiligung der Pleura: zu einem Erguss in den mediastinalen und interlobären Pleuraspalt rechts zwischen Mittel- und Unterlappen. Nach fünf Monaten ist dieser spurlos verschwunden.

Die hier geschilderten Beobachtungen — und ich habe nur einige besonders markante Fälle aus einer grösseren Reihe herausgehoben — zeigen das durchaus bekannte Bild und die Verlaufsform der kindlichen Drüsentuberkulose, zwei von ihnen mit einer mässiggradigen Aussaat in die Lungen. Gemeinsam ist ihnen der sonderbare Röntgenbefund. Bei Besprechung des Befundes von Fall 2 habe ich erwähnt, dass eine pneumonische Verdichtung des Mittellappens bei der Röntgenuntersuchung unter besonderen Umständen ein recht

ähnliches Verhalten zeigen kann. Ich glaube aber, dass in den angeführten Fällen die Deutung der Bilder als mediastinal-interlobärer Erguss nicht angezweifelt werden dürfte. Der Versuch, die Deutung durch Probepunktion zu bestätigen, scheint nicht notwendig und wäre auch wenig aussichtsreich. Sie wurde nicht ausgeführt, da sie nicht unbedenklich ist.

Wir haben also bei Kindern mit Mediastinaldrüsentuberkulose (der Kürze halber seien hier und weiterhin auch die bronchopulmonalen Drüsen zu den mediastinalen gehörig bezeichnet) Exsudate in den Lappenspalt beobachtet, u. zw. so häufig und so gleichartig, dass darin keine Zufälligkeit gesehen werden kann. Die naheliegende Erklärung für dieses Verhalten gibt uns die Anatomie. Ueber die Topographie der mediastinalen Lymphknoten sind wir durch SUKIENNIKOWS Untersuchungen unterrichtet. Er schildert die Lage und gruppenweise Anordnung um Trachea, Bifurkation und Hauptbronchien. Ueber Beziehungen zwischen Drüsen und Pleura konnte ich aber keine systematischen Angaben finden. Die einzige Andeutung in dieser Richtung habe ich von W. NEUMANN erhalten (jüngst niedergelegt in »Formenkreis der Lungentuberkulose«, Springer, Wien 1924). In seine Gruppe von »Tuberkulosemasken« bezieht er manche Fälle sogenannter »Herzneurose« ein. Einzelne Lymphdrüsengruppen an der Bifurcation liegen unmittelbar dem Pericard benachbart. Eine Entzündung dieser Drüsen kann zu einer lokalen Entzündung am Pericard führen und eine solche lokale Pericarditis kann durch ihre subjektiven Manifestationen als »Herzneurose« in Erscheinung treten. In der Annahme, dass für die von mir geschilderten Beobachtungen analoge, eng nachbarliche Beziehungen zwischen Drüsen und Pleura verantwortlich sein dürften, habe ich auf NEUMANN'S Anregung die anathomischen Verhältnisse untersucht.

Um möglichst ursprüngliche Verhältnisse zu finden, habe ich vorzüglich die Lungen von Kinderleichen zur Untersuchung herangezogen. Neben mehreren systematischen Präparationen habe ich alle durch mehrere Monate in unserer Anstalt zur Obduction gelangten Leichen im Sinne der angeführten Fragestellung untersucht. Die systematische Darstellung der Verhältnisse soll Gegenstand einer besonderen Mitteilung sein. Als für den hier behandelten Gegenstand bedeutungsvoll will ich anführen, dass rechts am Hauptbronchus des Unterlappens medial ein grösserer Lymphknoten (oder eine Gruppe von 2 oder 3) liegt, der nicht von Lungenparenchym umgeben ist. Der grosse, schräge Lappenspaltschneidet gerade auf ihn zu ein, so dass er, bloss von Pleura überkleidet, gewissermassen den Boden des gegen den Hilus zu blind endenden

Spaltes ist. Wenn man den Mittellappen hinaufklappt, ist diese Drüse zumeist nicht nur an Farbe und durch Tasten zu erkennen, sondern ragt oft fast halbkugelig in den Lappenspalt vor. In Fällen von Tuberkulose der Lunge mit Beteiligung der bronchopulmonalen Drüsen findet man nicht selten diese Drüse vergrößert, verkäst, den medialen Teil des Lappenspalts verödet. Ähnliche Verhältnisse findet man links. Während der Lymphknoten rechts fast ausnahmslos nur von Pleura bekleidet ist, findet man ihn links vom Lappenspalt ausgehend in vielen Fällen erst unter einer mehrere Millimeter dicken Decke von Lungenparenchym.

Die geschilderten eng nachbarlichen Verhältnisse einzelner Lymphdrüsen zur Pleura machen es verständlich, ja fordern geradezu, dass entzündliche Prozesse in diesen Drüsen die Pleura mitergreifen. Sehen wir doch allenthalben im Körper, dass die serösen Häute an Krankheitsprozessen der von ihnen bekleideten Organe in ihrer Art teilnehmen. Und bei dem regelmässigen Vorkommen einer nur von Pleura überzogenen Drüse im blinden Eck der unteren Hälfte der schrägen Lappenspalte sind die Pleura dieser Lappenspalte und die Pleura mediastinalis naturgemäss am häufigsten mitbetroffen. Synchien der mediastinalen Pleura und der interlobären Pleuren, besonders deren medialer Teile, sind ein häufiger Befund bei der Obduktion Erwachsener. In allen ihren Erscheinungsformen und Stadien kann die Tuberkulose in ausgiebiger Weise zu pleuritischen Prozessen führen und es ist ja auch keineswegs die Tuberkulose allein, die solche Veränderungen setzt. Immerhin scheint es berechtigt, einen Teil dieser Veränderungen an den Pleuren den frühen und gewissermassen abortiven Formen der Tuberkulose zuzuschreiben. Und wenn ich hier über beträchtliche Ergüsse in die Lappenspalte berichtet habe, so mag in vielen anderen Fällen eine auch mit dem angewendeten Verfahren nicht nachweisbar trockene Pleuritis die »Hilusdrüsentuberkulose« begleiten.

Für das Zustandekommen exsudativer mediastino-interlobärer Pleuritiden ist das Freisein der Pleuraspalten Voraussetzung. Akute Entzündungen der mediastinalen Lymphknoten sind im wesentlichen auf das jugenliche Alter beschränkt. Diese beiden Umstände bewirken es, dass wir Bilder von der dargestellten Art vorwiegend an jugendlichen Patienten gewonnen haben; aber nicht ausschliesslich. Ein Beispiel sei kurz angeführt.

Beobachtung 5: Frau Franziska Sch., 46 Jahre, mit einem endokarditischen Mitralfehler, erkrankt plötzlich mit Seitenstechen, Husten, Fieber, Nachtschweiss. Es wird eine Verdichtung der linken Lungenspitze und eine linksseitige Pleuritis mit geringem Erguss festgestellt. Die Röntgenuntersuchung (Abb. 5 a) bestätigt den Befund und erweitert ihn. Rechts ist der



Fig. 5 a. Sagittalbild.

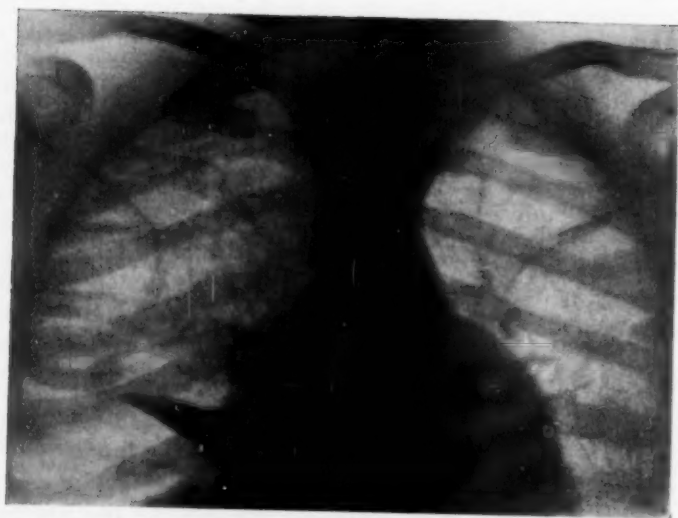


Fig. 5 b. Kreuzhohlstellung.

mediale Teil des Unterfeldes von einem mässig dichten, homogenen Flächenschatten eingenommen, der nach oben, aussen und unten sich allmählich verliert. Im Bereiche dieses Schattens erscheint die Lungenzeichnung (Gefässe) verstärkt. Die Durchleuchtung in Kreuzhohlstellung (Abb. 5 b) zeigt einen dem Herzschatte anliegenden, beiderseits scharf begrenzten Spornschatten, der mit seiner Spitze etwa bis zur halben Breite des Lungenfeldes reicht. Mediastino-interlobärer Erguss zwischen Mittel- und Unterlappen.

Epikrise. Neben einem pleuritischen Exsudat konnte bei dieser 46-jährigen Patientin an einen zum Teil interlobär angeordneten Hydrothorax gedacht werden (Befunde von Helm). Es ist nicht Sache des Röntgenbefundes, das zu entscheiden. Das bleibt der klinischen Diagnosenstellung vorbehalten. Und klinisch bestand kein Anhaltspunkt für eine Kreislaufstörung. Was immer die Art und Entstehung des Ergusses war, durch die angewendete Untersuchungstechnik war es möglich, ein nach den allgemeinen Erfahrungen als Lungenverdichtung zu deutendes Röntgenbild als das Bild eines mediastino-interlobären Ergusses richtig zu erkennen.

Was bedeuten die geschilderten Verhältnisse für die *Klinik*? In vielen Fällen wird die Tuberculose der mediastinalen (und bronchopulmonalen) Lymphknoten von einer exsudativen Pleuritis der mediastinalen und interlobären Pleura begleitet, die mit Vorliebe rechts den Spalt zwischen Mittel- und Unterlappen einnimmt. In anderen Fällen dürfte es bloss zu einer trockenen Pleuritis kommen. Beide Formen können zu Schwartenbildung und Adhaesionen an den beteiligten Pleuren führen. Hier sei eine Bemerkung über die Deutung eines klinischen Symptoms eingefügt. Das Zeichen von PETRUSCHKY, die Spinalgie, wird bekanntlich nicht auf eine unmittelbare Klopfempfindlichkeit der entzündlichen Drüsen selbst zurückgeführt, sondern auf eine Beteiligung des Periostes einzelner Wirbel. In ähnlicher Weise könnte man auf Grund der geschilderten Verhältnisse versucht sein, auch die paravertebrale Dämpfung nach KRÄMER in vielen Fällen nicht unmittelbar auf die vergrösserten mediastinalen Drüsen zu beziehen, sondern sie auf Exsudate im mediastinalen und interlobären Pleuraspalt oder auf Schwarten nach dort abgelaufenen Pleuritiden zurückführen. Für die Prognose kann die durch die geschilderte Untersuchungsart gewonnene Aufklärung von entscheidender Bedeutung sein. Der allgemeine und lokale klinische Befund (siehe Beobachtung 2), bestärkt durch ein irrig gedeutetes Röntgenbild, wird häufig eine üble Prognose stellen lassen. Gemeinhin werden ja derartige Röntgenbilder als vom Hilus sich verbreitende Lungentuberculose oder als Lappeninfiltrationen gedeutet. Wir haben wohl in jugendlichem Alter mit der Rückbildung ausgedehnter

Lungenverdichtungen zu rechnen (ich erinnere nur an Epituberkulose und Paratuberkulose, ELIASBERG-NEULAND, WAGNER, LANGE und die Befunde von HARMS); immerhin wird die Aufklärung dass eine die Drüsenaffektion begleitende exsudative Pleuritis vorliegt, gestatten, die Prognose günstiger und richtiger zu stellen. Das gilt für die akute Erkrankung. Aber auch für später scheinen mir die an der Pleura zurückgebliebenen Spuren, Schwarten und Adhäsionen von Bedeutung zu sein, und ich will kurz darauf eingehen. POSPISCHIL, der meines Wissens als Erster auf den eminent chronischen Charakter der Pertussis hingewiesen hat, bezeichnet die basalen Abschnitte, besonders aber den Mittellappen rechts als Lieblingssitz der Pertussispneumonie. WENCKEBACH (persönliche Mitteilung) beobachtet rechts im Mittellappen und im benachbarten Teil des Unterlappens eine Form rezidivierender und chronisch indurierender Pneumonie, die durch ihre Neigung zu Bronchiektasienbildung ausgezeichnet ist (mehrere damit übereinstimmende Fälle eigener Beobachtung). Mag eine grössere Anfälligkeit der rechten Lunge, besonders deren basaler Anteile wie immer erklärt werden, es scheint mir nicht von der Hand zu weisen, dass chronische Veränderungen an der Pleura dabei eine wesentliche Rolle spielen. Die grosse Mehrzahl aller Erkrankungen der Lunge führt zu einer Mitbeteiligung der Pleura. Andererseits aber bedeuten chronische Veränderungen der Pleura durch die Einschränkung der respiratorischen Bewegung, durch Störung der Blut- und Lymphzirkulation eine Aenderung der lokalen Kondition und damit eine Aenderung, vielfach wohl Erhöhung der Anfälligkeit der benachbarten Lungenabschnitte.

Was bedeuten die geschilderten Verhältnisse für die *Röntgendiagnostik*? Durch die Aufdeckung eines mediastino-interlobären Ergusses gelingt es in Fällen, wo »Drüsentumoren« nicht unmittelbar zur Darstellung gelangen, eine Affektion der mediastinalen, durch den Mittelschatten gedeckten Drüsen mit grösster Wahrscheinlichkeit zu erweisen.

Die gezeigten Bilder bekräftigen die von vielen Autoren erhobene Warnung, jeden vergrösserten Hilusschatten ohneweiteres als (tuberkulöse) »Hilusdrüsen« oder gar als »Hilustuberkulose« zu bezeichnen. Pleuritische Prozesse an der mediastinalen und interlobären Pleura können vergrösserte Hilusschatten hervorbringen.

Letztens lehren die dargelegten Befunde von neuem, dass es notwendig ist, bei jeder Untersuchung der Lunge den Thorax in allen nur möglichen Richtungen abzusuchen. Die vielfach ausschliessliche Anwendung der üblichen sagittalen Richtung bei Durchleuchtung und Photographie ist oft ungenügend und kann in ihren Ergebnissen irreführen.

ZUSAMMENFASSUNG

An Hand von Beispielen wird gezeigt, dass es im Verlaufe von Tuberkulose der mediastinalen Lymphknoten häufig zu einer exsudativen Pleuritis im mediastinalen und interlobären Pleuraspalt kommt, mit Vorliebe rechts zwischen Mittel- und Unterlappen. Erklärt wird diese Komplikation aus den engnachbarlichen Beziehungen gewisser Drüsengruppen zur Pleura. Zum Nachweis dieser Ergüsse eignet sich neben querer Durchleuchtung besonders die Untersuchung in Kreuzhohlstellung. In dieser Stellung sammeln sich Schatten von früher ganz uncharakteristischer Form zu dichten, scharf begrenzten, dem Mittelschatten anliegenden Schatten von Dreieck-, Vogel-schnabel- oder Spornform. Es wird die pathologische, klinische und röntgen-diagnostische Bedeutung dieses Krankheitsbildes erörtert.

SUMMARY

The writer shows by examples that an exudative pleuritis in the mediastinal and interlobar pleural space especially to the right between the middle and lower lobes frequently occurs in the course of tuberculosis of the mediastinal lymph nodes. This complication is explained by the extremely close relation of certain groups of glands to the pleura. Besides roentgenoscopy in the transverse plane an examination in "saddle-back" position is especially suited for proving this exudate. In this position, shadows that before had quite an uncharacteristic shape collect to form dense, sharply circumscribed shadows having the shape of triangles, bird's beak's, or spurs and situated close to the middle shadows. The pathological, clinical, and roentgenological significance of this aspect of the disease is discussed.

RÉSUMÉ

Tout en citant des exemples l'auteur démontre qu'au cours d'une affection tuberculeuse des ganglions médiastins il arrive souvent qu'il se forme une pleurésie exsudative dans l'espace interlobaire et médiastin de la plèvre de préférence à droite, entre les lobes moyen et inférieur. Cette complication s'explique par les rapports étroits entre certains ganglions lymphatiques et la plèvre. Pour mettre en évidence ces épanchements il est, en dehors de la radiographie oblique, avantageux d'examiner le sujet en attitude lordotique. Dans cette attitude les ombres qui auparavant n'avaient rien de caractéristique s'assemblent épaissies, nettement délimitées, autour de l'ombre de milieu, en adoptant la forme de triangles, de becs d'oiseaux et d'éperons. L'auteur discute cette affection au point de vue pathologique, clinique et radiodiagnostique.

RESUMEN

Al mismo tiempo que cita ejemplos, el autor demuestra que durante el curso de una afección tuberculosa de los ganglios mediastinos sucede a menudo que se forma una pleuresia exudativa en el espacio interlobular y me-

diastino de la pleura, preferentemente a la derecha, entre los lóbulos medio e inferior. Esta complicación se explica por la íntima relación entre ciertos ganglios linfáticos y la pleura. Para poner en evidencia estos derrames, a parte de la radiografía oblicua, es muy ventajoso examinar el enfermo en posición lordótica. En esta posición las sombras que anteriormente no presentaban carecterística alguna, aparecen gruesas, netamente delimitadas, alrededor de la sombra del centro, adoptando la forma de triángulos, de picos de pájaro y de espolones. El autor discute esta afección desde el punto de vista patológico, clínico y radio-diagnóstico.



OBSERVATIONS RESPECTING THE SENSE OF PAIN IN SKIN EXPOSED TO ULTRA-VIOLET RAYS

by

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In the course of my researches in the field of light-therapy I have found that both sunlight and the rays of a quartz-lamp in strong doses bring about certain changes in the skin's sense of pain which would seem to be of interest both from the light-biological and the sense-physiological point of view.

Even during the latent period after irradiation, following the disappearance of the heat-erythema, but ere the least trace of light-erythema can be descried, hyperalgesia is often plainly manifest, together with an increase in the number of skin points displaying sensation of pain when subjected to the algesimeter test.

When the light-erythema has reached its climax, the hyperalgesia is strongly pronounced; the threshold-value is low and the sensibility to pain is intense in proportion to the strength of the irritation. At the same time it is a rare thing or, indeed, absolutely impossible to discover a single point which is not a seat of pain. A striking fact is the duration of the painful sensation. A single momentary prick with the algesimeter needle may cause a pain-impression lasting many minutes, exceptionally, as in Case 20 below, up to 77 minutes. The pain exhibits repeated crescendoes and decrescendoes, usually also intervals of complete absence of pain, lasting usually from 15 to 20 seconds. Reiterated sensations of pain are thus observed following a single irritation — "succedan polyaesthesia". Later impressions are then often considerably more painful than previous ones in the same series. When the inflamma-

tion of the skin has begun to diminish, it sometimes happens that the first sensation which is manifested on the application of the irritant, whether it be a pin-prick or pressure by some blunt object, has the character of a contact sensation which, after a considerable latent period (in Exp. 21, fourteen seconds), is followed by a sensation of pain that is often intense and sometimes reiterated. The after-sensations may either be localized to the point in which the pain was called forth, or else radiate into the surrounding skin area. In one case with excessively long after-sensation I was able, while it continued, to anaesthetize the place of prick and its surrounding area with novocain and found that this interference did not put an end to the after-sensations nor did it influence their localization or intensity. The sensations of pain continued and were localized, even after the anaesthetization, to the point of puncture and its surrounding area, in spite of the fact that the latter were now completely insensible to new interferences of the same kind and strength as the initial one. The radiated sensations, also, continued as before.

In some persons subjected to experiment the sensation of pain is sometimes succeeded by a distinct sensation of cold which either brings it all to an end, or else alternates with reiterated sensations of pain. The pain sometimes increases or decreases rhythmically like the pulse. The occurrence of the retarded or reiterated sensation of pain is comparatively often coincident with reflexes of the capillary vessels.

Just as the sense of pain is evidently influenced even before the occurrence of the erythema, so also many of the peculiar circumstances indicated above can be observed long after the acute light-reaction has passed away. Thus, for instance, Exp. 20 was carried out 62 days after exposure to the rays, when the skin showed brown pigmentation but no trace of redness, swelling, or other acute signs of inflammation.

In some cases I carried on the same investigations with regard to the skin-erythema remaining after erysipelas. The results were negative, but the cases were too few to allow of generalization. In the erythema induced by mustard-paper I discovered brief and slight after-sensations of pain.

I will now proceed to show why I am convinced that it really is the exposure to the *ultra-violet* rays that produces the observed phenomena. With a quartz spectrograph the rays of the quartz lamp were photographed, filtered through a 1 per cent solution of quinine sulphate in a quartz absorption vessel in 2 millimetre layers. It appeared that the solution completely absorbed all rays

of shorter wave-length than $391 \mu\mu$ — thus, all ultra-violet rays — but transmitted the visible light. A skin area was then irradiated with the same quartz lamp, and, moreover, be the identical methods employed in all the investigations as to the sense of pain, excepting that the rays were also now filtered through 2 mm. of 1 per cent quinine solution. After this exposure there was no change as regards the sensation of pain of the person subjected the experiment who constantly, after exposure without the quinine filter, exhibited the changes described.

The retarded and reiterated sensation of pain is by no means a new discovery. It was described by NAUNYN as far back as in 1879, and afterwards studied by REMAK, LEYDEN, GOLDSCHIEDER, THUNBERG, v. FREY, and others. Even the normal sense of pain is characterized by a latent period that was first shown by v. FREY. In cases of mechanical irritation, THUNBERG¹ fixed the time of reaction for the first pricking sensation at an average of 18/100th second, while for the second pricking sensation the mean time was 96/100th second. In cases of thermic irritation, THUNBERG found a time of reaction amounting to 6 seconds (heat-irritation); ALRUTZ² found a latent period of 20—45 seconds after cold-irritation.

The delay is more pronounced in certain pathological states, e. g. in some diseases of the spinal cord (compression paraplegia and tabes) as also in peripheral nervous diseases (neuritis). In the case of tabes, a succedan polyaesthesia is described.

Exposure to powerful ultra-violet rays seems to induce a more extreme degree of these disturbances of the sense of pain than has otherwise been observed. Thus, it is possible to artificially lengthen the duration of the sensation of pain, to provoke a succedan polyaesthesia and, under certain circumstances, an excessively long latent period for the first sensation of pain. By these means we are able to create more favourable conditions for the study of these phenomena and, consequently, perhaps also of the sense of pain in the normal state. From the light-biological standpoint it is certainly of interest that a pain-sense-reaction can be proved prior to the light-erythema.

It was not until the present paper was being completed that I became aware of a communication on the same subject by FR. v. GRÖER and W. v. JASINSKI (Lemberg), through a notice in »Klinische

¹ Untersuchungen über die bei einer einzelnen momentanen Hautreizung auftretenden zwei stechenden Empfindungen. Skand. Arch. f. Physiologie. Bd. 12. 1902. Sid. 394.

² Die verschiedenen Schmerzqualitäten. Skand. Arch. f. Physiologie. Bd 21. 1908—1909.

Wochenschrift» 1. Jahrg. No. 14: »Über die Beeinflussung der Schmerzempfindlichkeit der Haut durch Quarzlampenbestrahlung». These authors employed heat-irritation and found a primary hypalgesia, that could be observed only after a feeble irradiation, and a secondary hyperalgesia appearing before the light-erythema. The latter condition bears out my own observations. On the other hand, my observations are absolutely at variance with the statement of these authors that hyperalgesia reappears as soon as pigmentation takes place. It may be that the divergence is connected with the different irritants we employed or with different quantities of light. The authors have not published an account of their investigations. As far as I know, nothing else has been published regarding the sensibility to pain of an illuminated skin. On this point I have received expert confirmation.

Manner of conducting the experiments.

Besides occasional observations on a large number of patients undergoing light-treatment, I have carried out series of systematic investigations on myself, on my medical assistants, and on some nurses. Before irradiation in these cases, the sensibility has always been tested the regions adjacent to that subsequently irradiated, or symmetrically on the other half of the body. The part selected for irradiation, however, has not been previously subjected to sensibility tests, nor to any other injury. In the majority of the cases, a minor area on the volar side of one arm has been exposed to the rays of a 220 volt quartz burner with alternating current, placed at a distance of 25 centimeters from the skin surface for four or five minutes.

Only one irradiation has been employed for each series of investigations and the changes produced by this irradiation have been followed by numerous investigations of the sensation of pain all through the various stages of the erythema, until normal or fairly normal pain-reactions have again been established.

For the sensibility test I employed (a) the ALRUTZ's algesimeter, set at I or IV (hereafter called Alr. alg. I or IV); (b) a glass rod with bulbous extremity of about $1\frac{1}{2}$ mm. diameter; (c) a fine thread dipped in ice-vinegar, according to the method advanced by v. FREY.¹ The algesimeter was employed only for momentary irritation; it was pressed against the skin surface and immediately lifted up again.

¹ Verspätete Schmerzempfindungen. Z. f. Neurologie und Psychiatrie. Bd LXXIX H. 1/3.

The glass rod was used to apply momentary and moderately strong pressure to one point and also to do a rapid linear stroking of the skin with light pressure. The persons experimented on have been allowed to manage the instruments themselves after having received the necessary instructions, and have marked their application by "Now." They have then indicated their impressions as briefly and distinctly as possible, e. g. "pricks", "smarts", "increasing", "diminishing", "over". The record-keeper, watch in hand, has put down these statements, and also the times in seconds. It goes without saying that time-marking of this kind will be approximate. But even a more exact method would scarcely have been an improvement. It is impossible for the person subjected to experiment to state the time exactly, especially with regard to the *cessation* of pain in those cases when it slowly abates. In these simple investigations, moreover, this is of no particular importance, as there is no question of quantitative determinations and the time-periods dealt with are, in general, relatively long.

It ought to be specially mentioned that none of the persons experimented on have exhibited any signs whatever of nervous disease.

Experiment-record.

From the numerous records kept I here submit a small selection illustrating the observations of which I have given a comprehensive summary in the preceding pages.

Exp. No. 1 illustrates the increase of the number of pain-reacting points after irradiation.

Five adjacent skin areas of equal size were selected for the experiment. In one of these a prick was made with Alr. alg. IV at 100 different spots; in 73 cases distinct pain was felt, but in 27 there was no sensation of pain. All the areas were then irradiated at the same time and at the same distance from the quartz lamp for 4 minutes. The skin between and in the vicinity of the spots was protected by black cloth. Then the four areas unaffected by the algometer were examined in proper order during the time between the irradiation and the appearance of light-erythema, with the following result:

25 minutes after irradiation, spot No.	I	showed	86	per cent	pain-spots
40 " " " " " "	II	"	86	"	"
55 " " " " " "	III	"	93	"	"
70 " " " " " "	IV	"	95	"	"

On examination of spot No. IV, the spots had just begun to show a faint redness.

The different sensibility tests having been carried out on different skin areas exclude the explanation that the successive increase might be due to skin irradiation arising from previous algometer tests.

At the climax of the skin-erythema the figure is usually 100 per cent, i. e., not a single spot can be detected where the algesimeter does not provoke pain. The frequency of the pain spots in non-irradiated skin varies in different skin-areas and different individuals. v. FREY,¹ in tests with "Stachelborst" on the flexor side of the upper arm, obtained an average of 78 per cent pain sensation (58 per cent pure pain + 20 per cent combined pain and contact sensations). In numerous tests on the volar side of the lower arm I have arrived at figures closely corresponding to these.

Exp. No. 2 on another person; same method.

Before irradiation 69 per cent pain spots
 1½ hours after irradiation . . 89 " "

(the light-reaction begins to manifest itself towards the end of the algesimeter test).

1 month 8 days after irradiation 91 per cent pain spots
 1 " 11 " " " " 90 " "
 2 months 4 " " " " 93 " " (slight pigmentation).

(Skin distinctly brown without redness)

A control test 1½ hours after irradiation symmetrically on the non-irradiated arm showed 74 per cent pain spots.

A control test in an adjacent non-irradiated skin-area 2 months and 4 days after irradiation showed 75 per cent pain spots.

Even before the light-reaction was perceived it was positively demonstrated that the pricks were considerably more painful here than in non-irradiated skin. They felt "like regular little stabs".

The following experiments Nos. 3—13 comprise a selection from some hundred recorded sensibility tests on the same person — Ingeborg J., Medical assistant, 36 years old, light complexion, ashy-blond hair, grey iris with brown edge next to the pupil. They all belong to the same series, i. e., they were carried out within the same irradiated area at different times after a single irradiation.

Before irradiation.

Exp. No. 3 Alr. alg. I. On the volar surface of the left lower arm. Distinct momentary pain; no after-sensation of pain.

Exp. No. 4 Alr. alg. IV on non-irradiated skin.

Immediate pain remaining two or three seconds. After an interval of 5 seconds, 8 seconds after pricking, there was "an unpleasant sensation which cannot be called pain" lasting about 8 seconds.

Exposure for 5 minutes to the rays of the quartz lamp.

Two hours and 15 minutes after exposure, pricking sensations were noticed in the skin of the irradiated area, and three and a half hours after irradiation, manifest erythema. Next day, intense redness and pain at the least touch.

Three days after irradiation.

Exp. No. 5 Alr. alg. I on the irradiated area.

¹ l. c.

immediate sensation of pain lasting 4 seconds
 followed by pause 7 seconds
 then a second sensation of pain lasting 8 seconds

Total duration 19 seconds.

Seven days after irradiation: the skin is blue-red in the centre of the irradiated area; at the periphery, more brown with incipient desquamation. The pain is about equally intense in both different-coloured areas.

Exp. No. 6 Alr. alg. I, in the brown area.

Pain perceived immediately.

A first period of pain of 24 seconds
 followed by a pause of 13 seconds
 then a second period of pain of 72 seconds
 with two crescendoes and decrescendoes.

Total duration 109 seconds.

Exp. No. 7. Momentary pressure with the glass rod in the red-blue area: immediate pain.

1st period of pain	5 sec.	The after-sensation much more intense than the first pain, felt like sharp pricks made with a very fine needle.
pause	12 "	
2nd period of pain	22 "	
pause	12 "	
3rd period of pain	12 "	

Total duration 63 sec.

Nine days after irradiation, the skin was partly desquamated.

Exp. No. 8. Stroking the desquamated area with the glass rod.

Immediate effect: tactile sensation but no pain.

Then a pause of 4 seconds, followed by
 sensation of pain lasting 61 seconds (violent smarting)
 pause 19 seconds
 2nd sensation of pain 35 seconds

Total duration 119 seconds.

Exp. No. 9. Alr. alg. IV, on the not yet desquamated area.

Immediate effect: tactile sensation, but no pain.

Then a pause of 9 secs.
 1st period of pain of 29 "
 pause 20 "
 2nd period of pain 19 "

Total duration 77 secs.

Eleven days after irradiation, the skin was completely desquamated and showed a predominating pink colour with intense red spots and white streaks.

Exp. No. 10. Alr. alg. IV. Immediate pain.

1st period of pain 18 seconds
 pause 12 "
 2nd period of pain 27 "
 pause 11 "
 3rd period of pain 9 "

Total duration 77 seconds.

Seventeen days after irradiation. The illuminated area, brown-red.

Exp. No. 11. Ice-vinegar in a small drop according to v. FREY's method, on the irradiated area. No sensation within the first fourteen seconds. 1st period of pain 146 seconds (smarting, which abates and increases several times).

pause	14	>	
2nd period of pain	36	>	
itching	15	>	
3rd period of pain	32	>	(pricking pain)

itching lasting a good while. At the place where the vinegar was dropped a red spot is visible.

The same day for comparison:

Exp. No. 12. Ice-vinegar on the non-irradiated arm.

No sensation within the first 20 seconds.

1st period of pain	87	>	
pause	17	>	
itching	108	>	a momentary pricking during this period.

Fifty days after irradiation. The irradiated skin is entirely brown; all acute symptoms of inflammation have quite vanished.

Exp. No. 13. Alr. alg. IV on the irradiated area.

Immediate pain lasting 93 seconds with 3 crescendoes and decrescendoes. Intense pricking pain. No after-sensation of pain.

Exps Nos. 14—20 were performed on R. L. 31 years of age, a nurse (colour of skin light brown, hair dark brown, colour of iris brown). She had just been appointed to the hospital, and during the whole period of investigation had no inkling of previously recorded observations nor of what was expected. She was, moreover, unusually clear-headed and determined; appeared not to be liable to suggestion. At the numerous experiments *before* the irradiation, an immediate sensation of pain was registered at the pain-spots. This persisted 5 seconds at the most and there were no after-sensations. During the latent period prior to the appearance of the erythema there were much more intense sensations of pain with prolonged duration up to 19 seconds, but no after-sensations.

The person in question often had a distinct impression of cold succeeding the sensation of pain, as in the following experiment performed on the day after irradiation.

Exp. No. 14. Alr. alg. IV on an non-irradiated area.

Immediate sensation of pain.

1st period of pain	6 secs.
pause	8 >
2nd period of pain	26 >
followed by sensation of cold lasting	20 >

Total duration 60 secs.

Exp. No. 15. Five days after irradiation. Alr. alg. IV on the irradiated, brown-red skin. There is immediately a violent pricking sensation which abates after 18 secs., then increases again and, after 64 secs., when it is only faintly perceived, is combined with a feeling of cold. The pain ceases

definitely 79 seconds after the algesimeter prick has been made but the sensation of cold remains for a further period of 37 seconds. Total duration: 116 secs.

For more than two months, numerous sensibility tests were made on the irradiated area. In general, results were obtained which only confirmed the statements given above. From certain points, however, sensations of pain emanated which were of excessively long duration. This occurred especially at the demarcation line between normal and erythematous or dermatitic skin. The symptoms of inflammation are, moreover, usually most intense there.

Exp. No. 16, performed 3 days after irradiation. Alr. alg. IV.

Immediate sensation of pain.

1st period of pain 8 min. 38 secs.; increasing and decreasing smarting at first at the place where the prick was applied and in the adjacent area within the erythema; after 43 seconds, "really bad smarting" farther down towards the hand; definite localization impossible. Afterwards a recurrent smarting but only within the erythema. Sensation of cold 20 secs. Pause 16 secs., followed by repeated impressions of pain (smarting); during the intervals, sensations of cold, "shiverings". Incessant alternations of cold and smarting. "It feels as if the concentrated cold produced smarting". The smarting was mostly localized in the irradiated area, but sometimes extended down towards the wrist about 10 cm below the erythema spot. The whole thing was definitely over 30½ minutes after the moment of irritation. No mark from the pricking, and consequently no bleeding or other severe lesion of the tissue.

Fourth day after irradiation.

Exp. No. 17. Alr. alg. in or immediately outside the boundary line of the erythema area. The effect was a pain which, with a single interruption of 6 seconds, lasted 26½ minutes. This time, no cold was felt. The sensation was characterized as smarting with occasional fine pin-pricks partly radiating partly localized to the whole of the irradiated area and, thus, not concentric around the place of the pricking.

Five days after irradiation, the irradiated skin area was red-brown, not rising above the surrounding skin, not desquamating.

Exp. No. 18. Alr. alg. IV at, or in the neighbourhood of, the same point as was employed in Exp. 16. The previous prick left behind a slight redness which had blended with the large erythema, forming an insignificant jag on its otherwise straight and sharply defined boundary.

The effect during the first 40 seconds was a sensation of pain of varying intensity at the prick-point followed, as in Exps. 16 and 17, by a more intense smarting in the whole of the irradiated area and, in addition, a pricking sensation in the whole arm, most intense at the wrist but felt also in the upper arm. "It pricks like a sleeping foot." No sensation of cold.

When this had gone on for 18 minutes, regional anaesthesia was produced by injection of a few c.c. of 2 per cent novocain-adrenalin (2 drops in 10 c.c. solution) around and at some distance from the erythema. The experiment was made in order to discover whether the after-sensations would hereby cease or continue, whence certain conclusions might be drawn concerning the location of the processes constituting the immediate cause of the after-sensations.

Immediately upon the production of anaesthesia, sensibility tests were

made with the algesimeter at several points within the erythema. Nowhere was there any sensation of pain or contact, but at three special points the impression "hot" was recorded. Following the injection a smarting was first noticed in the bend of the elbow and in the erythematous area. Two minutes later, there was a pause of 3 minutes, during which nothing was felt from the arm. Five minutes after the anaesthesia had been produced, pain was again perceived in the whole erythematous area, increasing and decreasing in intensity. For four minutes the smarting was localized entirely to the irradiated area which, when pricked with Alr. alg. IV, proved completely anaesthetized. Pains radiating down towards the hand set in afterwards. Eleven minutes after the novocain injection, a pause of about one minute ensued, during which nothing was felt in the arm. There was then a recurrence of the pain of exactly the same character and localization. This continued for another 19 minutes, until 31 minutes had elapsed after the injection. Full anaesthesia remained twenty minutes after the injection; and then 8 algesimeter pricks were made, of which 2 produced pain, 1 heat, and 5 no sensation at all. The sensations of pain thus ceased definitely 49 minutes after the commencement of the experiment and 31 minutes after the anaesthetization. Sensibility was then fully restored. During the whole time there were no sensations of cold.

It is possible to imagine that the sensations continuing after sensibility had begun to return were produced by the algesimeter pricks, by which they had been excited. If, therefore, we only reckon to that moment, the initial prick had given rise to a series of sensations of pain that persisted for 38 minutes and continued with undiminished strength and the same localization even after the erythematous area, where the pain was most constant had been rendered perfectly insensible to repeated pricking with the algesimeter. This argues in favour of the supposition that the after-sensations in this case were conditioned by processes not in the peripheral sense organs or nerve endings, but more centrally situated.

Exp. No. 19. Next day the experiment was repeated in reverse order. The same erythema-area was first anaesthetized by a novocain-adrenalin injection. Then followed a period of waiting of 12 minutes, during which nothing was felt from the experimental area or elsewhere in the arm. A prick was now made with Alr. alg. IV inside the erythema area, but neither tactile, painful nor any other sensations were noticed.

Fourteen minutes after the novocain injection, an algesimeter prick (IV) was made on the edge of the erythematous area at the same point as in Exp. 16 or at least very near it. After $1\frac{1}{2}$ minutes smarting was felt down towards the wrist; this sensation persisted for $3\frac{1}{2}$ minutes. After a pause of one minute, a kind of indefinite sensation was again felt down towards the hand along the radial edge of the lower arm. This vanished after 3 minutes. Not until 20 minutes after the last algesimeter prick did smarting occur in the erythematous area and its vicinity. This lasted 17 minutes. Later in the day, there was itching in the experimental area.

The circumstances of this case are complicated and can scarcely be explained without further investigations. The main fact, how-

ever, is the occurrence of the 12 sensation-free minutes following immediately upon the anaesthetization. One may be allowed to draw the inference that the pains alluded to in Exp. 27 which persisted after the novocain injection and were localized to the anaesthetized erythematous area were probably not caused by the pricks of the point of the injector.

Sixty-two days after irradiation, the irradiated area showed brownish-yellow pigmentation with no trace of redness. Repeated tests *within* the irradiated area resulted merely in the pain persisting for a longer period than normal, but no after-sensations of pain. *At the boundary* of the non-irradiated skin area there were much more intense pains of a far longer duration and followed by sensations of pain.

Exp. No. 20. Alr. alg. IV at one of the boundary-lines.

Effect: sensation of pain of the same character as in earlier experiments which was not definitely over until 77 minutes had elapsed. Here, the smarting was sometimes replaced by a sensation of cold. It is of some interest, perhaps, to note that during a great part of this time the pain was localized exclusively to a more recent erythematous area, six days old, situated a few centimeters lower down the arm. ("Anklingen auf Fernreize" Goldscheider.)

Finally, I will give an example of the vascular-reflex which is often coincident with the pain.

Exp. No. 21 performed 11 days after irradiation on V. M. (46 years old, colour of skin light, hair ashy blond, iris blue-grey).

The irradiated skin-area was stroked with the glass rod.

Immediate effect: Tactile sensation; no pain; after that a pause. Then, 14 seconds afterwards, pain and a pale streak in the track of the glass-rod occurred simultaneously.

Pause	14 secs.
1st period of pain	48 >
pause	24 >
2nd period of pain	7 >
pause	6 >
3rd period of pain	23 >

Total duration 122 secs.

The white streak remained about 4 minutes, being consequently still visible when the pain had definitely ceased. Its width was about 4 mm. The bulb of the glass rod with which the skin had been irritated had a diameter of about $1\frac{1}{2}$ mm.

The abnormally long period of after-sensation, in some cases repeated, could be provoked under the given circumstances in most of the persons whom I tested. It is possible that it would have occurred in all if they had been instructed as to what was to be expected. This, however, has been purposely omitted so as to avoid

the possibility of suggestion. It is, of course, possible that some of the exceptions may be explained by deficient powers of observation on the part of the person experimented on. It is a remarkable fact that the subjects of the experiments never spontaneously experienced similar sensations in the period between the experiments.

Hyperalgesia would seem to be constant, as is natural when an inflamed tissue is concerned.

The vascular reflex is by no means constant. It occurs also in the non-irradiated skin and also without any sensation of pain. In some persons, however, its occurrence is so often coincident with the commencement of the 1st period of pain or—when the latter is not perceptibly delayed—with the commencement of the 2nd period of pain, that one can scarcely help thinking that there is some connection between the two phenomena. Still, I have not studied this detail closely.

When it comes to explaining the delay and reiteration of the sensations of pain, opinions become divergent. This is no doubt because there is no unanimity as to what is the most fundamental point in the theory of sense of pain. The various theories must, of course, take into consideration and endeavour to explain such a unique phenomenon. Consequently there has been a great deal of discussion about the latency and reiteration of pain; indeed, this question may be said to have served as a touchstone for testing new theories of the sensation of pain.

The prevailing theory (FRÉDÉRICQ and v. FREY) rests on the principle of a specific nerve apparatus for the sense of pain: special pain nerves and special receptory contrivances (the intraepithelial nerveendings, or the epithelium itself). The latency of the sensation of pain is explained by THUNBERG and v. FREY by supposing that the mechanical or thermic irritant first gives rise to a probably physico-chemical process in the nerve-endings or in the surrounding medium, through which the nervous irritation is transmitted. The latent period of the pain corresponds to the time needed for the said intervening process. A more powerful irritant can act simultaneously on the end organ and on the nerve itself. The latter conducts the irritation immediately, the former only after the definite latent period. The twofold sensation of pain is explained in that way by THUNBERG.¹

GOLDSCHIEDER² still energetically defends his theory which denies the existence of specific pain nerves and explains pain as being a

¹ l. c.

² Das Schmerzproblem. 1920.

special quality of sensations within the modality of the "mechanical sense" provoked by strong irritation of the tactile nerves. The pain generally manifests itself as a secondary phase succeeding a primary and faint contact sensation. This secondary phase has a central or spinal cause. The tactile irritation, when converted into nerve-irritation, provokes peripheral changes which are not immediately equalized, so that a successive irritation-series arises which has a tetanizing effect on the spinal nerve cells in the posterior cornu.

These nerve cells get hereby into a state of super-irritability which causes discharges in a centripetal direction, sensations of pain, and simultaneously to radiation, radiating pains. The delay of the sensation of pain depends, according to GOLDSCHIEDER, on this process of summation and discharge located in the grey matter of the spinal cord, and probably lasts longer than the peripheral state of irritation. GOLDSCHIEDER also describes a 3rd phase, always of less intensity and seldom attaining to the pain-threshold except in the face where it may be augmented to the degree of a pricking sensation. GOLDSCHIEDER offers no explanation of this exception. Is it not tempting to guess at a light-effect? That the 3rd phase should constantly be of less intensity does not agree with my observations of *irradiated* skin.

According to GOLDSCHIEDER it is thus the nerves of pressure which convey sensations of pain, and the pressure spots are also sensitive to pain under *strong* irritation. Thus, there is only a quantitative difference between pressure spots and pain spots. When suitable methods of irritation are employed, the outer skin-layer seems to be all capable of smarting.

According to OPPENHEIMER's theory, sensations of pain are due to the action of the vasomotor nerves.

In our present stage of knowledge it is certainly impossible to offer a fully satisfactory and irrefutable explanation of the sensation of pain of the irradiated skin. In any case, I am not sufficiently versed in physiology to be qualified to enter into these difficult questions. I will only illustrate briefly a few of my observations which touch on the central part of the disputed ground. Exp. No. 18 seems to corroborate the supposition of GOLDSCHIEDER that more central processes are the cause of the after-sensations of pain — at least under the pathological circumstances we are now concerned with. They also confirm his statement that this centrally situated process probably lasts longer than the peripheral state of irritation.

The increase in the percentage of pain-spots after exposure to ultra-violet rays may possibly be explained as a consequence of the

lowering of the threshold-value, as a symptom of hyperalgesia. THUNBERG has pointed out that an irritation is conducted to the end-organ not only from a point lying vertically above but also from points lying beside it, in which case, however, the effect of irritation diminishes with the distance. If, now, the threshold-value is greatly lowered, the range of the end-organ should be increased and, maybe, at last their rayons will blend so that no analgetic point can be detected. According to GOLDSCHIEDER, again, all pressure-spots are also pain-spots although some are distinguished by their slight sensibility. On sufficient lowering of their threshold-value it must follow that their capacity of communicating pain will more easily be manifested.

Both GOLDSCHIEDER and v. FREY seem to hold that a high threshold-value is a necessary condition to the delayed sensation of pain. In the above-mentioned experiments Nos. 8, 9 and 21 the sensation of pain was delayed 4, 9 and 14 seconds respectively but the threshold-value was at the same time abnormally low.

How can light act on the sense of pain in this manner? One is, at first, perhaps, inclined to regard these disturbances of the sensibility to pain as consequences mainly of light-dermatitis and indirectly of the irradiation. This explanation is, however, evidently incorrect or, at least, incomplete. The changes in the sense of pain can be traced, as I have shown, considerably earlier than the light-erythema or dermatitis and they still remain when all the acute inflammation symptoms have vanished and when the skin displays no other macroscopically demonstrable changes than pigmentation. In any case, the phenomena can, consequently, not be satisfactorily explained by the pressure-action of inflammatory products in the skin even if that possibly is a contributory factor in the climatic stage of the reaction.

It is, perhaps, not quite unreasonable to imagine a light-absorption in and a *direct* light-action on the intra-epithelial nerve endings or, eventually, nerve apparatuses which serve the sensation of pain. According to HACKER, v. FREY, and THUNBERG¹ these are the outermost of all the skin-nerves, lecithin is a substance extremely sensitive to light, and the rays of the quartz lamp, although they have but slight power of penetration into the skin, are known for certain to be able to exercise direct biological action at the depth with which we are here concerned.

Other explanations are also possible, but the question can hardly

¹ THUNBERG: Untersuchung über die relative Tiefenlage der Nervenenden. Skand. Arch. f. Physiologie Bd 11. 1903.

be decided without closer investigation. The considerable functional disturbances and the long time needed for restoration point, at any rate, to extensive damage to the apparatus of the sensibility to pain.

As appears from my paper, the majority of the peculiarities which characterize the sense of pain of the irradiated skin exist, so to say, in miniature even in normal sense of pain. It seems, therefore, possible that further study of the phenomena here described may yield some contribution of value to the discussion of the normal sense of pain. It is within the bounds of possibility that a clue may be found to the problem of light-reaction. A histological investigation of the changes undergone by the skin nerves at different times after irradiation with the quartz-lamp and commencing as early as the latent period of the erythema, would be of especial interest.

SUMMARY

Exposure to ultra-violet rays produces distinct changes in the sense of pain of the skin. This light-effect has a shorter latent period than the light-erythema and can therefore be demonstrated earlier than that, and it persists long after the acute erythema has disappeared. It manifests itself, *inter alia*, by hyperalgesia and by a prolonged duration, often excessively so, of the painful sensation that has been produced by a momentary irritation and which also exhibits either reiterated crescendoes and decrescendoes or else one or more intervals ("iterated painful sensations" or "succedan polyaesthesia").

Distinct sensations of cold are sometimes observed which either alternate with the iterated painful sensations or bring the whole to an end.

When the light-erythema has begun to abate, it happens that the irritation immediately causes a painless tactile sensation followed first by an interval and then, after a comparatively long latent period (far longer than the normal latent period of sensations of pain), by an intense and frequently iterated painful sensation.

Not unfrequently the retarded sensation of pain appears simultaneously with a capillary vascular reflex.

The after-sensations are localized to the point from which they originated, and to the immediate neighbourhood. They frequently radiate also into more distant skin areas. In one experiment the writer had an opportunity of anaesthetizing the smarting skin area (the point of the pricking and its surrounding area) while the after-sensation lasted. Although there was complete insensibility to new interferences, the after-sensations that were localized to same area, continued.

The writer mentions the previously known phenomena that have been observed in normal and pathological conditions and are analogous to those described above, as well as their explanation according to the most important theories of the sense of pain. The irradiated skin is surely an easily accessible and, in all probability, a yielding field for studies of the sense of pain which is still puzzling in many respects.

ZUSAMMENFASSUNG. Wird die Haut ultravioletten Strahlen ausgesetzt, so erzeugt dies deutliche Veränderungen betreffs ihrer Schmerzempfindlichkeit. Diese Wirkung des Lichtes hat eine kürzere latente Periode als das Lichterythem, sie kann deshalb früher demonstriert werden als das letztere und sie hält noch lange an, nachdem das akute Erythem verschwunden ist. Sie manifestiert sich, inter alia, durch Hyperalgesie und durch eine — oft exzessiv — verlängerte Dauer des Schmerzgefühls, dass durch einen momentanen Reiz erzeugt wurde und das auch entweder wiederholte Crescendos und Decrescendos zeigt oder aber ein- oder mehrmalige Unterbrechung (»wiederholte Schmerzgefühle« oder »sucedane Polyästhesie«).

Manchmal sind deutliche Kältegefühle zu beobachten, die entweder mit den wiederholten Schmerzgefühlen alternieren oder das Aufhören derselben markieren.

Wenn das Lichterythem abzunehmen begonnen hat, kommt es vor, dass der Reiz sofort einen schmerzlosen Tasteindruck hervorruft, der zuerst von einem Intervall gefolgt ist und dann, nach einer verhältnismässig langen latenten Periode (weit länger als die normale latente Periode bei Schmerzgefühlen) von einer intensiven und häufig wiederholten Schmerzempfindung.

Nicht selten tritt das verspätete Schmerzgefühl gleichzeitig mit einem kapillaren Gefässreflex auf.

Die Nachempfindungen sind an ihrem Ausgangspunkt lokalisiert und in seiner unmittelbaren Umgebung. Häufig strahlen sie auch in weiter abgelegene Hautgebiete aus. Bei einem Versuche hatte Verf. Gelegenheit die schmerzhafteste Hautstelle (den Punkt des applizierten Stiches und seine Umgebung) zu anästhesieren, während die Nachempfindung noch anhielt. Obzwar hier völlige Unempfindlichkeit für neue Reize bestand, dauerten die Nachempfindungen, die auf demselben Gebiet lokalisiert waren, noch fort.

Verf. erwähnt die bereits bekannten Phänomene, die unter normalen und pathologischen Bedingungen beobachtet wurden und den oben beschriebenen analog sind, und bespricht auch ihre Erklärung nach den wichtigsten Theorien über den Schmerzsin. Die bestrahlte Haut ist sicherlich ein leicht zugängliches und sehr wahrscheinlich besonders ergiebiges Felt für Studien über den Schmerzsin, der noch in vielen Beziehungen rätselhaft ist.

RÉSUMÉ. L'exposition aux rayons ultraviolets produit des altérations marquées dans les sensations de douleur de la peau. Cet effet de la lumière est d'une période de latence plus courte que l'erythème de lumière et peut donc être démontré plus tôt que la dernière; il persiste longtemps après que l'erythème aigüe a disparu. Il se manifeste, entre autres lignes, par de l'hyperalgesie et par la prolongation, souvent très considérable, de la sensation douloureuse qui a été provoquée par une irritation momentanée, et qui présente ou des augmentations et des diminutions répétées ou encore un ou plusieurs intervalles, »sensations douloureuses répétées« ou »polyesthésie succédante«.

Des sensations nettes de froid sont quelques fois observées qui ou alternent avec les sensations douloureuses répétées ou marquent la fin de tout le processus.

Quand l'erythème de lumière a commencé de céder, il arrive que l'irritation produit immédiatement une sensation tactile indolore, suivie d'abord par un intervalle et puis, après une période de latence relativement longue (beaucoup plus longue que la période de latence normale des sensations douloureuses), par des sensations douloureuses répétées.

Il arrive assez souvent que la sensation retardée de douleur apparait simultanément avec un reflexe des vaisseaux capillaires.

Toutes ces sensations sont localisées à l'endroit ou elles sont nées et à la région voisine immédiate. Elles le propagent aussi à des régions dermiques plus éloignées. Dans un cas l'auteur a eu l'occasion d'anesthésier la région douloureuse (l'endroit des picotements et la partie environnante) pendant que la sensation douloureuse durait encore. Bien que la sensibilité aux nouvelles excitations fût complètement nulle, les sensations douloureuses précédemment existantes localisées au même endroit continuaient à se faire sentir.

L'auteur mentionne les phénomènes déjà connus, observés dans des conditions normales et pathologiques et analogues à ceux qui ont été décrits ci-dessus et les essais d'explication selon les théories les plus importantes de la sensation de douleur de la peau. La peau irradiée est sûrement un champ facilement accessible et en toute probabilité, riche en résultats pour l'étude de la sensation de douleur, qui de beaucoup de points de vue est encore énigmatique.

RESUMEN. La exposición a los rayos ultravioletas produce alteraciones apreciables por sensación de dolor en la piel. Este efecto de la luz es de un periodo latente más corto que la eritema de la luz y puede, por lo tanto, ser demostrada más rápidamente que ésta última; continua durante un largo tiempo, después de haber desaparecido la eritema aguda. Se manifiesta, entre otras maneras, por la hiperalgesia y por la prolongación, a veces muy considerable, de la sensación dolorosa que ha sido provocada por una irritación momentánea y que presenta, o bien aumentos y disminuciones repetidas o bien, uno o varios intervalos «sensaciones dolorosas repetidas» o «poliestesia sucesdante»(?).

A veces pueden apreciarse sensaciones límpidas de frío que, o bien alternan con las sensaciones dolorosas repetidas o bien marcan el final de todo el proceso.

Cuando la eritema de la luz ha comenzado a ceder, sucede que la irritación produce inmediatamente una sensación táctil indolora, seguida, al principio por un intervalo y después, a continuación un período latente relativamente largo, (bastante más largo que el período latente normal de las sensaciones dolorosas) con sensaciones dolorosas repetidas.

Sucede muy a menudo que la sensación retardada del dolor aparece simultáneamente con un reflejo de los vasos capilares.

Todas estas sensaciones se localizan en el lugar en donde se originan y en la región vecina inmediata. Igualmente se propagan a las regiones dérmicas algo más alejadas. En un caso, el autor ha tenido ocasión de anestesiar la región dolorosa (el lugar de la picazón y la parte cercana) mientras duraba todavía la sensación dolorosa. Si bien la sensibilidad a las nuevas sensaciones fué completamente nula, las sensaciones dolorosas existentes con anterioridad localizadas en el mismo punto, continuaban dejándose sentir.

El autor menciona los fenómenos ya conocidos, observados en condiciones normales y patológicas y análogas a aquéllos que han sido ya descritos anteriormente y las ensayos para explicarlos, según las teorías más importantes de la sensación de dolor en la piel. La piel irradiada es seguramente un campo fácilmente accesible y con toda probabilidad, rica en resultados para el estudio de la sensación de dolor, que desde muchos puntos de vista es todavía un enigma.

A CASE OF BISMUTH SUBNITRATE POISONING WITH FATAL ISSUE FOLLOWING AN INJECTION OF BECK'S PASTE

by

Axel Westman

Ever since preparations containing bismuth subnitrate have begun to be more universally employed in medicine, cases of poisoning have been observed, some of which have been reported more or less fully in the literature. Poisonings of this kind have been seen to occur partly as the result of partaking of bismuth subnitrate per os, either for purely therapeutical purposes or as a contrast agent in roentgenography of the digestive tract, and partly also following external application to wounds, fistulae, and such like. These cases of poisoning have aroused fresh interest since the bismuth paste introduced by BECK came into use, and several authors have reported more or less serious complications following the employment of this paste. However, the number of cases published being fairly small, and since all the details of the toxicological aspect are not fully known, a report on another case of typical bismuth poisoning with fatal issue might be of some interest.

L. J., female, aged 22 years (Case No. 271/23), was admitted to the Hospital of Umeå on account of pneumonia of the right side, Feb. 2, 1923. Nine days ago she had been taken ill with pains in the right side of her chest, chills, coughing, and forced respiration. On admission, her general condition was greatly affected. Temperature, 39.5° C.; pulse rate, 110. The right lung had a marked dullness, strongest at the base, sibilant bronchial respiration, and short mucous râles. No exudate was obtained on puncturing. The left lung was normal. Urine normal. A roentgenogram of the lung showed a diffusely dense shadow in the field of the right lung. The dense shadow had a sharp upper margin medial to the air-filled lung tissue, which fact argued for a large exudate or empyema. (Dr. STRÖM). On exploratory puncture being made two days later, pus was drawn, and then 1,100 c. c. of thick exudate were evacuated. Since, however, the fever as well as the dullness over the lung persisted and pus was still obtained by a second

exploratory puncture, thoracotomy with resection of a piece of the ninth rib was performed, Feb. 23. Culture of the pus did not yield any growth. On Feb. 27, the dullness was considerably decreased and only a scant secretion from the fistula persisted. The patient was allowed to get up, afebrile. On April 3, the drainage tube was removed, since the secretion had almost ceased. On April 16, the patient had a rise in temperature and increased discharge of pus from the fistula. To ascertain whether it led into a circumscribed abscess, the fistula was injected with 75 c. c. of BECK's bismuth paste and was then examined roentgenographically. A complete pneumothorax was then found in the right side of the chest. In the lower region of the pleural cavity there was a collection of paste and the top of the cavity was coated with the same material. (Dr. STRÖM). Three days after the injection of the paste (April 19), the patient began to complain of pains in her mouth on eating. On examination, several, small, pus-filled blisters on a dark ground were seen on the gingiva and underneath the tongue. The gingiva had a dark margin round the teeth. Staphylococci were obtained by cultivating specimens from the pus blisters. The temperature rose to 38° C. at night. Increased secretion from the fistula, from which pus mingled with paste escaped. The general condition was unaffected. The patient had a small swelling and slight pains in her left knee. On April 30, the following entries were made in the case sheet: The stomatitis has developed rapidly, and on the gingivae of the upper and lower gums, on the floor of the oral cavity, in the buccal cavity, and on the anterior portion of the tongue there are now large necrotic infiltrations and pus vesicles on a dark ground. Strong foetor ex ore. Profuse secretion of saliva, and considerable subjective troubles. The patient can partake of liquid food, only with great difficulty. The regional lymph glands are swollen and very tender. The patient's general condition is somewhat deteriorated, but there are no local symptoms apart from the stomatitis.

Suspecting it to be a case of bismuth poisoning, energetic attempts are made to wash out all the remaining paste. The stomatitis is treated after the method of PFANNENSTILL. May 11. The stomatitis has developed further and large, foul-smelling, necrotic shreds come away from the mucous membranes. The dark margin round the teeth has increased, the patient is now hardly able to swallow liquid food. The general condition is very much deteriorated. The patient is very emaciated. The temperature is 38°—39° C. Pulse rate, about 90. The respiration is normal. Only a slight secretion from the fistula. The symptoms from the left knee have subsided entirely. May 17. The general condition is to-day very much worse. The temperature is about 37° C. The skin and sclerae are icterically discoloured. The stomatitis is as before, but the patient complains also of pains in her throat. She is unable to take liquid food on account of the pains in the mouth and throat. She has diffuse, colicky pains in her entire abdomen, and repeated foul-smelling diarrheas, and has vomited once or twice. The urine is very dark-coloured. HELLER's test, positive. ESBAUGH's test: 2 %. The sediment contains a scanty number of red and white blood corpuscles and a few hyaline casts. HAMMARSTEN's test reaction, positive. Examination of blood: Hgb. 60 per cent; red blood corpuscles, 3,200,000; white corpuscles, 19,800, 72.5 per cent being leukocytes, and 27.5 per cent, mononuclears; no eosinophils; no pathological cell forms; no deposits of pigment in the blood cells. May 23. In the last few days the patient has been sinking steadily. The

icterus has increased very much. Her mind is deranged. No symptoms of nervous irritability. The temperature is subnormal. The pulse is small, its rate, about 100. The respirations are slightly accelerated. The stomatitis is much improved. Repeated profuse bleedings from the nose during the last 24 hours. Considerable diffuse pressure-tenderness over the abdomen. Liver and spleen are not palpable. Frequent, very bloody diarrhea during the last 48 hours. Almost pure blood has been passed to-day. The urine contains a large amount of albumin but only very little sediment (white and red blood corpuscles, and hyaline casts). To-night, there has been a further deterioration of the condition, and death has ensued.

Post mortem examination, May 24. (Dr. AKERREN.) Habit of body, constitution, and musculature are ordinary. Skin and sclerae are very yellow-coloured. At the back of the right thorax there is a small open wound leading into the pleural cavity. A short piece of the ninth rib has been resected. Oral cavity: the gums are somewhat swollen, but have no sores or films. A narrow bluish-black margin round the teeth. The anterior portions of the tongue are normal. Right over the dorsum of the tongue there is a superficial, grayish-black, raw surface with patches of thin yellowish-gray fur. When cut into, the tongue shows everywhere a pale, fleshy appearance. The tonsils are small but not coated, the cut surface is pale grayish-red. The larynx is pale, and has no coatings. The glottis, the larynx, and the trachea show everywhere a pale, thin, and smooth mucous membrane, as does also the oesophagus. The thyroid gland is small (weight: 20 grams), and has a pale brownish-red colour. The upper two-thirds of the right pleura contain air. The right lung is lying collapsed at the side of the vertebral column, except its lowest portion (below the site of the thoracotomy) where it is attached to the thoracic wall and the diaphragm by extensive fibrous adhesions. The pleural surface has all round a grayish-red or grayish-yellow, 1 to 2 millimeters thick, viscous, and fairly adherent coating. The pleural tissue itself is thickened, grayish-red, and has a large number of new-formed vessels. The lung is very much collapsed, and of a tough consistence. On section, the cut surface is found to be of a pale grayish-red hue. Only an extremely small amount of clear, frothy liquid can be squeezed out of any portion of the lung. The left pleura does not contain any foreign matter; the surfaces of the pleura are everywhere smooth and glistening. The left lung is like an air cushion, its cut surface is grayish-red, and yields everywhere a moderate amount of clear, frothy fluid. The bronchi are empty, their mucous membrane pale. The cardiac sac contains a small amount of yellow, almost clear fluid. The surface of the pericardium is everywhere smooth and glistening. The heart is relaxed, and hardly of normal size (weight, 200 grams). Its valves and orifices are normal. The cardiac muscular tissue is grayish-red, and has no indurations. The coronary vessels and the aorta are normal. The peritoneal cavity contains no foreign matter, the surface of the peritoneum is everywhere smooth and glistening. The spleen is small (weight, 110 grams), its cut surface, dark red, its consistence, firm. The liver is of almost normal size (weight, 1,550 grams). Its consistence is much looser than normal, its colour is clayey-gray with a touch of yellow. Its cut surface has the same colour and fairly distinct lineaments. The papilla Vateri without remark. The biliary ducts contain no foreign matter, their mucous membrane is smooth and even. In the stomach there is about half a liter of fluid the consistence of pap, containing

numerous small dark-brown lumps and some mucus. The mucous membrane is everywhere smooth and pale. The duodenum and small intestine have moderate quantities of similar contents; the mucous membrane is everywhere pale. PEYER's glands have the usual appearance. The contents of the large intestine and the rectum are fairly abundant, have a dark-brown colour and a consistence of thick pap. The entire mucous membrane is dark-brown and swollen. Large irregular ulcers (some of them being almost as large as a penny-piece) coated with dark-brown, tough, rugged films are found in several places, especially in the sigmoid and pelvic colon. The ulcers has not perforated. The mesentery and the mesenteric lymph glands are normal. The pancreas is normal. The kidneys are considerably enlarged (their total weight is 450 grams) and of equal size. Their consistence is very loose. The cut edge is swelling strongly. The cut surface has a pale reddish-yellow colour and fairly distinct lineaments. The glomeruli are small and pale. The line of demarcation between the cortex and the medulla is somewhat indistinct. The capsule is easily removed from the smooth cortical surface. The mucous membranes of the kidney pelvises, the ureters, and the bladder are pale. The vagina, the uterus, and the adnexa are normal.

Microscopic examination (Dr. WILTON): The liver: the interlobular connective tissue septa are widely isolated one from another by oedema, and the cells in the periphery of the acini show fatty degeneration. The structure is well preserved, though in some few places the acinous cell units are broken up by loose cellular connective tissue. The gall ducts and the vessels accompanying them are infiltrated with round-celled foci, in which different phases of regenerating gall duct epithelium can be observed. Kidneys: the glomeruli show no changes, except for a few pericapsular cell infiltrations, where also polynuclear leucocytes can be seen. The epithelial cells of the renal tubules are swollen and stain faintly. Here and there, especially in the epithelium of the convoluted tubules, fine granules are found which stain deeply with haematoxylin, and which have coalesced in some places into one homogeneous mass. The lumina of the renal tubules are filled with desquamated cells which have collected here and there to cellcasts that block the lumen. As distinct from these light casts there are deeply stainable ones which are formed by large, homogeneous, non-nucleated cells. Similar cells are also found, although sparingly, in the interstitial tissue which, in the marrow, is infiltrated with blood. Cylinders of blood cells are found in the large renal tubes. The spleen: excepting blood in the sinus, there is nothing remarkable to be seen. The mucous membrane of the colon presents an intense inflammatory process with ulceration and pseudomembrane formation as well as strong polynuclear infiltration. A grayish-brown, finely dotted pigmentation is seen extracellularly as well as intracellularly, especially in the cells of the mucous membrane.

A sample of the bismuth paste, one kidney, some liver tissue, and a piece of the large intestine were sent the Board of the Medical Department of the Home Office to be examined at the laboratory of the Public Analyst. On examination, the paste was found to contain, besides fat and zinc oxide, basic bismuth nitrate amounting to about 21 per cent, and a bismuth compound was found in all the specimens examined. Some of the large intestine and its contents were examined as to their percentage of chromium, zinc, and arsenic, but the result was negative.

As mentioned before, the bismuth subnitrate poisonings are divided into two large main groups: Those occurring after ingestion of the preparation per os, or those appearing after external application to wounds, fistulae, abscess cavities, and such like. The two groups differ one from the other not only with regard to the manner of application but also as to their toxicological aspect. Most of the published cases of poisoning by bismuth subnitrate introduced into the digestive channel have presented a very rapid clinical course which has not unfrequently ended with death, even within twenty-four hours. The clinical aspect has presented the following characteristics: Rapid deterioration of the general condition, with heavy, stertorous breathing, rapid pulse, and a characteristic, cyanotic, pale-grey colouration of the skin and mucous membranes. Not unfrequently there is a strong rise in temperature, and nervous symptoms both of irritability and of paralysis occur, too, in the form of perturbation of mind, hallucinations, attacks of tonic or clonic cramp, apathy, somnolence bordering on complete sopor. The presence of methaemoglobin in the blood has been proved, and the symptoms have been regarded as being to an eminent degree caused by the blood change. The production of methaemoglobin is regarded as due to a nitrite poisoning, in which the subnitrate of the bismuth compound is changed into nitrite by bacteria in the intestine.

The cases of poisoning following an external application of bismuth subnitrate, whether this be employed in the form of a sprinkling powder or as BECK's paste, present a clinical aspect that differs in many respects from the one described. The poisoning can have an acute onset also in these cases, though not so rapid as it is after a resorption from the intestine has taken place, but most often it takes a lengthy course extending over weeks or months. Inflammatory changes in certain parts of the digestive tract and organic degenerations are the most dominating features in the picture, and it is generally considered that these symptoms are caused by the metal component of the preparation. By comparing the experiences from experiments on animals and from the clinical cases of bismuth poisoning that have been published, the following changes have been found to be characteristic of this poisoning: Stomatitis in association with sores on the tongue and the mucous membrane of the mouth, profuse salivation, and a metallic margin on the gingiva. Inflammatory degenerative changes in the intestinal canal, especially in the large intestine. Degenerative changes in the liver and kidneys, which latter organs remind in certain respects of the kidney seen in cases of poisoning by corrosive sublimate. The question to what extent the blood changes observed are to be interpreted as an effect

of the metal or the nitrite component does not seem to have been fully solved as yet. It is, however, a remarkable fact that hardly in any of the cases hitherto described have all of these changes been present at one and the same time. It has been possible to explain this as a consequence of the rapid or slow course taken by the illness, and thus two types have been set forth: the acute and the chronic bismuth poisoning. The most predominating features in the chronic cases are the symptoms from the mouth cavity and the intestines, and the prevalent view is that these are induced by the excretion of the bismuth from the organism. In the acute cases, these symptoms have no time to manifest themselves before the fatal issue, but instead it is the changes in the parenchymatous organs that are the predominating features in the picture which, however, in the cases that are more fully known, (EGGENBERGER, REICH), is blurred by a co-existing nitrite poisoning.

An acutely developing case has been reported in detail by REICH, and since this case presents interesting similarities as well as dissimilarities to the one I have described above, a short resumé of REICH's case would perhaps be of interest in this connection. A fistula persisting after an abscess of the appendix was injected with 25 c. c. of BECK's paste. The very next day there was a rise in the temperature which was followed by a persistent fever. On the seventh day the gums were red and swollen, and then a metallic margin appeared, followed later on by small sores on the gums. There were no symptoms from the gastro-intestinal canal. On the tenth day the urine contained albumin (1 %) as well as granular casts. On the ninth day the respiration became frequent and later on stertorous. Coincidentally, there was an increase in the pulse rate up to 120, rising to 160 in the last days. On the ninth day icterus was observed and on the next day the skin had a livid, dirty-gray colour. Symptoms from the nervous system, in the form of somnolence, head-ache, and vertigo, appeared during the very first day. On the sixth day the patient had attacks of cerebral vomiting, and towards the end there was perturbation of mind, hallucinations, tenderness over the large nerve trunks, augmented reflexes, attacks of tonic and clonic cramp, and finally sopor. Death ensued on the eleventh day. On post mortem examination, the kidneys showed signs of parenchymatous degeneration of the epithelia of the tubes; in the liver there was a parenchymatous hepatitis. The gastro-intestinal canal did not present any changes. The blood of the corpse was lake-coloured and liquid. Large accumulations of blood pigments in the liver cells, kidneys, small intestine, and spleen went to show that there had been a considerable dissolution of red blood

cells. Icterus, and petechiae in the pleura, as well as capillary hemorrhages in the kidneys (Hb casts) and spleen suggested that a strong haemolysis had taken place. The fact that there had been a formation of methaemoglobin was evinced by a peculiar brown tint of the organs, resembling the one that is observed after poisoning by potassium chlorate. The presence of methaemoglobin in the blood could not be directly proved.

In the case reported by REICH there has, thus, certainly also been a nitrite poisoning, which fact is shown among other things by the formation of methaemoglobin. Whether the haemolysis, also, was a result of the action of the nitrite is a question which REICH has left unanswered. The changes in the rate of the pulse and respiration and also the peculiar characteristic colour of the skin are interpreted by him as sequels to the blood degeneration. On the basis of clinical observations previously published he thinks it likely that also the nervous symptoms have to be interpreted as an effect of the nitrite, although experiments on animals have shown that bismuth can induce irritation of the motor centers.

As a contrast to this case of REICH, another one described by DOX can be cited. Eighteen days after BECK's paste had been injected, painful sores appeared on the tongue, developing thirteen days later into a bad stomatitis attended with a metallic margin round the teeth. There were no symptoms from the internal organs. The case recovered.

The case that I have described above may be said to occupy an intermediary position between these two extreme types. The progress was subacute and the changes produced by the poisoning were of a very malignant nature. As early as on the third day after the injection of the paste, the stomatitis began to appear and developed then into the malignant type that is met with in certain cases of chronic bismuth poisoning, with necrotizing ulcerations, and sloughing of large diptheroid membranes, and with severe subjective symptoms. Not until much later, only on the thirty-first day, did the symptoms from the lower part of the digestive canal appear in the form of pains and attacks of profuse diarrhea which later on contained blood. Coincidentally, there were signs of renal lesion manifested by albumin, red and white blood cells, and casts, even though they occurred sparingly. Icterus set in at about the same time. Death ensued after thirty-seven days of illness. The anatomopathological finding, showing marked degenerative changes in the parenchymatous organs and a considerable ulcerous colitis, corresponded well with the clinical picture.

All changes that have been observed previously in cases of bis-

muth poisoning are, thus, met with in this case. All of them are present at one and the same time and in a grave form, which fact might perhaps be explained by the comparatively long duration of the illness. It is also a very interesting fact that all symptoms that have previously been interpreted as due to nitrite poisoning, are missing. Above all, there are no signs of any existing methaemoglobinemia, neither *intra vitam* nor *post mortem*. A spectroscopic examination of the blood was not made, it is true, but the blood of the corpse was of the usual character and no change in the colour of the organs could be observed. The skin did not have the dirty-gray, livid colour. Nor could any obvious change in the rate of pulse and respiration be observed. It is also interesting to note that all irritative symptoms from the nervous system were missing, which fact might perhaps afford a further support for the supposition that these should not be interpreted as due to the metal component of the preparation but as caused by the nitrite poisoning. Finally, the case in question does also serve as an illustration of the much-debated question whether the haemolysis is caused by the bismuth radicle or whether it is a phenomenon parallel to the formation of methaemoglobin. That an extensive haemolysis has been present seems evident from the following facts, among which the clinically observable ones, such as the bloody diarrheas which towards the end consisted of almost pure blood, and the frequent hemorrhages from the nose, ought to be specially mentioned. The icterus, too, is very likely a manifestation of the extensive dissolution of red blood cells. At the microscopic examination, numerous hemorrhages were found in the marrow of the kidneys, and blood casts, and also blood in the sinus of the spleen. On the basis of these observations one may therefore surely be justified in supposing that bismuth poisonings are able to cause haemolytic changes also in human beings, similar to those observed in experimental investigations on animals.

The prognosis of bismuth subnitrate poisoning is serious and the injection after the method of BECK is by no means without its risks. The cases of poisoning of this kind are rare, it is true, but they are nevertheless sufficiently numerous to prompt to great caution in the administration of the preparation. The case described above is, in an eminent degree, of a nature to call attention to the danger which, as has been pointed out before by REICH, exists on injecting bismuth paste into serous cavities.

SUMMARY

The writer gives an account of a case of bismuth subnitrate poisoning with a fatal issue following an injection of 75 c. c. of Beck's bismuth paste into an empyema cavity. The toxicological aspect is characterized by a grave stomatitis followed by metallic margin round the teeth, attacks of profuse diarrhea which became bloody towards the end, icterus, bleedings from the nose, and nephritis. All the changes are interpreted as caused by the bismuth component of the preparation, whereas there were no signs of a nitrite poisoning.

ZUSAMMENFASSUNG

Verf. berichtet über einen Fall von Wismuthsubnitrat-Vergiftung mit tötlichem Ausgang, der infolge einer Injektion von 75 ccm Beck'scher Wismuthpasta in eine Empyemhöhle eintrat. Das toxologische Bild charakterisiert sich durch eine schwere Stomatitis mit metallischem Rand um die Zähne, Anfälle von profuser Diarrhöe, blutige Entleerungen, in den letzten 2—3 Tagen vor dem Exitus, Ikterus, Blutungen aus der Nase und Nephritis. Alle Veränderungen erklären sich in diesem Fall durch die Wirkung der Wismuthkomponente des Präparats, während keine Zeichen einer Nitritvergiftung vorlagen.

RÉSUMÉ

L'auteur rend compte d'un cas d'empoisonnement par le Sousnitrate de bismuth avec issue fatale consécutive à une injection dans une cavité d'empyème de 75 cm. c. de pâte de Beck à bismuth. L'intoxication est caractérisée par une stomatite grave, suivie de l'apparition d'une lésion métallique autour des dents, par des accès de diarrhée profuse devenant sanguinolente vers la fin, de l'ictère, des saignements du nez et de la néphrite. C'est le bismuth, entrant comme ingrédient dans la préparation qui est considéré comme cause de tous ces troubles, aucun signe d'empoisonnement par le nitrate s'étant présenté.

RESUMEN

Un caso de envenenamiento por el subnitrate de bismuto. El autor da cuenta de un caso de envenenamiento por el subnitrate de bismuto con resultados fatales, como consecuencia de una inyección en una cavidad de empiema, de 75 cm. c. de pasta de Beck, de bismuto. La intoxicación se caracterizó por una estomatitis grave, seguida de la aparición de un ribete metálico alrededor de los dientes, por ataques de fuerte diarrea que se convirtió en sanguinolenta al final, ictericia, hemorragias nasales y nefritis. El bismuto, utilizado como ingrediente en la preparación, ha sido considerado como causa de todos estos trastornos, no habiéndose nunca presentado ningún síntoma de envenenamiento por el nitrate.

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TWO CASES OF LYMPHANGIOMA CYSTICUM ORIGINATING FROM THE OMENTUM HEALED WITH ROENTGEN TREATMENT

By

Emil Jerlov.

1. The first case refers to a 42-year-old man, an employee of a timber company, who was under treatment at the hospital of Karlstad from Febr. 23rd to March 22nd 1920.

The patient has for 16 years suffered from gastric catarrh with hyperacidity, but has improved by the treatment from year to year. In the autumn of 1919 there was a beginning tenderness in the epigastrium. The tenderness manifested itself the first time when he made a turn over the bar while doing some gymnastic exercises. Recently he noticed a tumour in the lower part of the abdomen. The patient has now sought medical advice for this tumour. He has not lost in weight, has no vomiting or nausea, but now and then slight eructation. Daily evacuations of the bowels which have been a little sluggish. He has never observed dark faeces, and has not suffered from icterus. No troubles on micturition.

Status praesens, Febr. 23rd. Good general condition. Very moderate bodily condition, tolerably fresh complexion. Afebrile. Lungs and heart normal.

Abdomen: In the lower part of the abdomen — the form and size of which is most suggestive of an uterus in the 5th month of gravidity — a tolerably firm tumour larger than a child's head is felt, its lower, thinner pole extending down into the true pelvis. In this part a ridge running in the sagittal plane, its diameter about that of a walnut, is felt on the tumour, the surface of which seems otherwise to be rather smooth. The prostate is of normal size.

Liver and spleen normal.

Urine normal. Sediment: a few pus cells and coli bacilli.

Stool examination: WEBER'S test negative.

As the tumour was supposed to be malignant, it was decided to perform laparotomy.

Operation: Febr. 27th, 1920 (CLARHOLM. Author assisted). The tumour proved to be a congeries of cystic formations varying in size from a pea to a plum and a goose-egg. The contents of most of the cysts were clear, and darker in some. The upper part of the tumour seemed to merge into the

omentum. Just below the navel it rapidly increased in breadth and depth and had here a firmer consistence and its largest cysts. The lower end of the conglomeration-cyst, which was narrow again, extended into the true pelvis and was all round firmly adherent to the upper pole of the bladder, the surrounding intestines, and the pelvic wall.

A radical operation was impossible. Some of the cysts were extirpated for diagnostic purposes. Abdominal suture.

The convalescence uneventful. Healed by first intention.

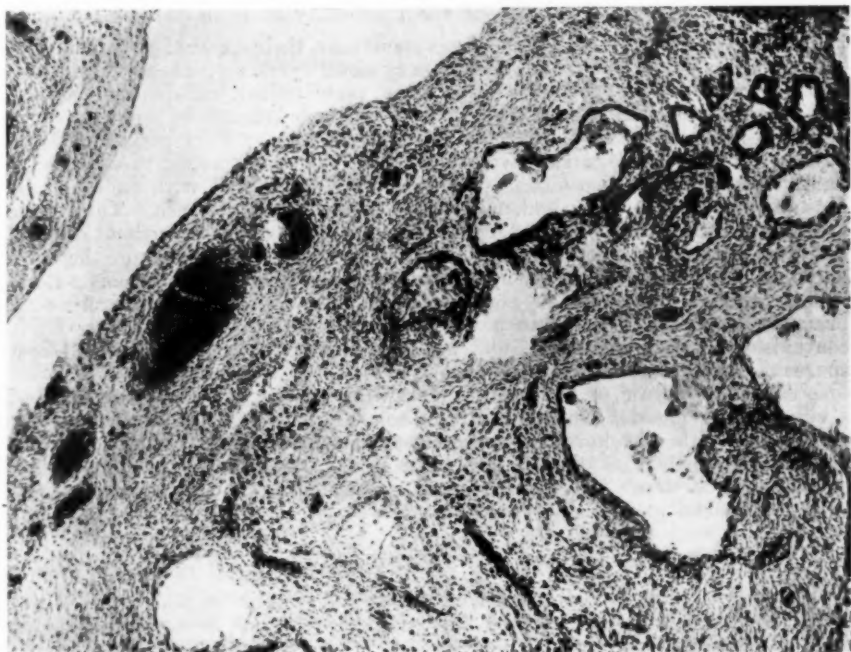


Fig. 1. Microscopic picture of the tumour of Case No. I.

Anatomo-pathological diagnosis:

The preparation was examined by two pathologists. Their statements completing each other to a certain extent, I have wanted to publish both. (Fig. 1).

No. I. (Examination by Dr C. O. FORSELIUS, Chief of the Pathological Anatomical Department of the Sahlgren Hospital).

The walls of the cysts are lined with a low layer of endotheliumlike cells. This layer is mostly quite membranous, but in some places it exhibits a slight swelling and is here often composed of many layers. This layer of cells, which is clearly defined, often rests on a stroma of connective

tissue in which a few muscular bundles are to be seen. For the rest the tissue is fibrous and subacutely inflamed. Inside the cysts there is a granularly coagulated fluid. Between the macroscopically visible cysts there are smaller microscopic ones, still more like ordinary lymph spaces. For my own part I arrive at the diagnosis *lymphangioma*, with some reservation for chronic lymph-stasis of high intensity.

No. II. *Pathol. Histol. Diagnosis: Lymphangioma Cysticum.*

(Prof. A. WESTBERG at the University of Uppsala).

Thin-walled cysts lined with a serous membrane, their sizes ranging from that of a walnut, a grape, and a pea, down to very small cysts. Hyperaemic vessels are outlined on the walls of the large cysts. Thin, usually clear, transparent contents.

Microscopic examination: The wall of the cyst consists of the peritoneum and a thin connective tissue membrane of its own, with a plexus of blood vessels situated between the two layers. The layers of connective tissue have partly merged into one. The cysts are everywhere lined with endothelium. Muscular or distinct lymphadenoid tissue is nowhere to be seen. The vessels are often surrounded by agglomerations of small rounded cells without distinct lymphoid structure (inflammatory?). In adjacent parts of the omentum there are multiple, very small cysts with only an endothelial wall, which sends out offshoots, resembling more or less dilated capillaries, into the environments, branching off and meeting in a net-work of capillaries without any visible contents (lymph capillaries) and which thus communicate with small cyst spaces (centres of growth).

The endothelium of the cysts and capillaries is everywhere composed of a single layer of cells, and is mostly of an ordinary, membranous appearance; part of the cells are, however, lying closer together, suggestive of the flattened cuboidal epithelium of some retention cysts. Attached to the endothelium of some cysts there is a small quantity of granular fibrinous coagula, and in a few places, small colloidal lumps.

We were, thus, face to face with a case of tumour in which no radical operation could be performed and the prognosis of which is very little known from the literature of to-day.

At the suggestion of Dr CLARHOLM the patient was sent to Professor G. FORSELL for *Roentgen treatment*. The latter has been kind enough to communicate to me the course of the treatment. No Roentgen therapy having previously been used in a case of this kind, as far as is known, I have taken the liberty to give an account of the details of the treatment.

(Extract from the notes of Professor GÖSTA FORSELL).

The patient was admitted for Roentgen treatment on March 23rd, 1920.

After the operation the patient felt subjectively well, had no intestinal or gastric troubles, his general condition was rather good. An elastic, pear-shaped tumour is felt in the middle of the abdomen. Its height above the symphysis is 20 cm., its greatest width at the middle of the tumour is 20 cm. It is narrowest towards the symphysis (See Fig. 2).

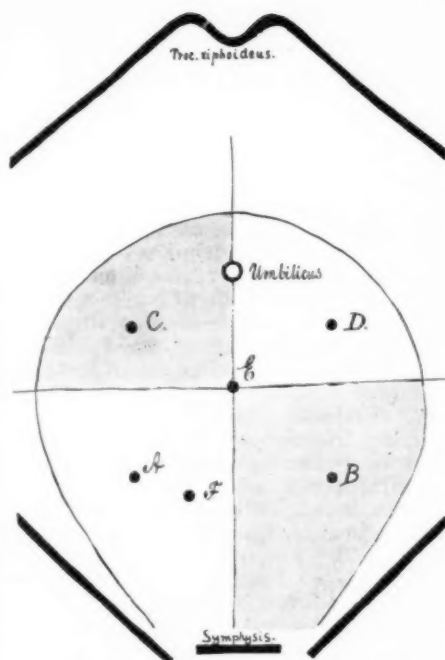


Fig. 2. Diagram of the extension of the tumour and the fields of treatment.

Pressure-tenderness in the right lower region of the abdomen. On either side of and above the tumour the intestines are filled with gas. The girth of the abdomen at the level of the iliac crest is 86 cm.

Treatment. The tumour is attacked through 4 different fields of entry, A, B, C, D, resp., and on two occasions through only one large field, E and F resp. (See Fig. 2).

The filter was each time = 0.5 mm. Cu. The skin focus distance = 24 cm. and the skin dose = $\frac{1}{2}$ H. E. D.

M. A = 2. Spark gap = 35 cm.

The first period of treatment commenced on March 23rd and continued during 8 days. The fields were treated in the order C, B, A, D, C, B, A, D.

The second period of treatment commenced on June 1st, and continued till June 4th, on the same principles as before. The disposition of the fields was now: B, C, A, D.

A rough estimate (according to VOLTZ) shows that in the fields C and D, where the tumour can be considered to have a depth of about 3 cm., its deepest part receives

at each treatment about $\frac{1}{5}$ — $\frac{1}{4}$ H. E. D. and in the fields A and B, where the depth of the tumour can be estimated at 6—10 cm, $\frac{1}{10}$ — $\frac{1}{8}$ — $\frac{1}{6}$ H. E. D.

Aug. 25th. No subjective troubles, good general condition. The tumour has diminished considerably. It is firmly elastic but can be distinctly displaced. Its height = 15 cm. Its width (measured across the whole palpable part) = 20 cm. As the patient cannot remain, only one treatment is given just on the tumour (at the point E).

Date	Field	Skin focus distance	Skin dose.	Deep-effect (according to VOLTZ) about
20/8	E	30 cm.	$\frac{1}{4}$ H. E. D.	$\frac{1}{10}$ H. E. D.

The patient returned on Dec. 13th 1920. He is now quite well. No gastric troubles. The tumour is distinctly diminished. It is 10 cm. high, and 11 cm. from side to side, does not extend very far to the left of the medial line. Treatment at the point F.

Date	Field	Skin focus distance	Skin dose.	Deep-effect (according to VOLTZ)
13/12	F	30 cm.	1/4 H. E. D.	1/10 H. E. D. per dose.
15/12	F	30 "	1/4 " " "	

The patient returned on May 31st 1921. (Dr. BERVEN). The general condition good. No pains. The skin of the abdomen is pigmented faintly brown. No tumour is felt on palpation over the abdomen. On rectal examination a firm, elastic tumour about the size of a hen's egg, is felt on the right side and is adherent to the abdominal wall; the upper limit of the tumour cannot be felt.

The principle of treatment is now the same as before except that the skin focus distance now is 30 cm. On May 31st the patient received treatment in the field A, on June 1st in the field B, on 2nd in the right back field, at on June 3rd in the left back field.

After-examination, March 15th, 1922 (Professor FORSELL).

Good general condition. Good appetite. No tumour can be felt on palpation either from the abdomen or from the rectum.

After-examination, Dec. 14th, 1922 (Professor FORSELL).

Good general condition. Gross weight, 70 kilos. Good appetite. Good strength. Normal evacuation. No palpable tumour. The skin of the abdomen is pigmented brown.

After-examination, Nov. 5th, 1923. (Professor FORSELL — Author).

Good general condition. Still quite able to work. Appetite and weight as before the illness. Evacuations still a little slow. No abdominal pains.

The abdomen: liver and spleen normal. No palpable tumour in the abdomen. No abnormal glands in the groins. Urine: normal.

Per rectum: prostate of normal size.

Nothing abnormal to be felt.

June 1924. Condition as before.

Case No. 2.

Diagnosis: Lymphangioma cysticum omentis + Salpingo-oophoritis chron. dextra.

The case refers to a 30-year-old unmarried woman, an office employee who was admitted to the Gynecological Dep. of the Sabbatsberg Hospital on July 2nd, 1923.

Nullipara. Menses have always been regular previously; they began at the age of 16—17 years. Their duration has been 3—4 days, and the interval, 2—3 weeks. In the summer of 1918, menorrhagia and a serious dysmenorrhea set in. The menses then lasted for 2 to 3 weeks. At the same time the patient lost 4—5 kilos in weight in 8 months. Admitted to this Dep. the first time on March 18th, 1919. The uterus was then anteflexed and rather enlarged. The portio short, bulky. The external orifice of the womb rounded, wider than normal, admits the tip of a finger. By means of vaginal

forceps it is easily dilated to admit the index finger. In the dilated cervical canal a rounded tumour about the size of a walnut can be felt. The tumour is twisted loose. Anatomico-pathological diagnosis: Myoma with glands.

The patient was discharged on April 5th, 1919, and was afterwards in good health until the new year of 1922 when she began to feel a pain in the left lower region of the abdomen. The pain was grinding, at times contracting; and increased gradually but disappeared at intervals. She has never been confined to bed, but the troubles have diminished when she has kept quiet. She cannot lie on her left side, as the pain will then increase.

The menses are now regular, and not particularly profuse, nor attended with pain. Slight discharge. No troubles on urination or evacuation. No venereal infection.

Consulted Professor AHLSTRÖM one June 28th, 1923.

Extract from his record of the status: Uterus anteflexed, a little dextroverted; to the left a rounded, elastic tumour about the size of a goose-egg, attached to but not coalescing into the left pelvic wall, and rising a little above the linea terminalis, so that it can also be felt on external palpation.

The temp. was 37° 7 C. 8—10 days ago, but has since then been afebrile. Status praesens on July 2nd, 1923: The general condition is unaffected. Skin, musculature, and weight are normal. Temp. afebrile. Pulse normal. Hgl = 68. (Sahli) Cor 0. Pulmones 0. Hepar and lien without remark. No palpable glands in the groins. Thyroidea not enlarged. Pupillar reflexes without remark.

In the left iliac region the upper pole of a tumour about the size of a fist can be felt.

Local status unchanged since Professor AHLSTRÖM's examination was made on June 28th. At the examination of two specimens of secretion taken on two consecutive days no gonococci could be found. Urine normal.

The patient lay under observation for 10 days and showed during the 3 last days a slightly afebrile temperature (not above 37° 8). On July 12th an operation was decided upon on the diagnosis: suspected ovarian cancer.

Operation, July 12th, (Author).

Resectio omentis partialis + Salpingo-oophorectomy dextra.

Median incision of the rectus sheath on the left side. Immediately upon opening the peritoneum there escaped from the abdomen a mass of coherent, cystic, gelatinous formations varying in size from a millet-seed to a dove's or hen's egg, with more or less clear or faintly bloodstained contents and suggestive of the cysts arising in cases of mola hydatidosa. The congeries of cysts which is very fragile is bluntly removed with the hand from the place — in the left lower half of the pelvis — where it appears to be most compact. Some of the cysts fall off at the attempt to lift the whole tumour. It appears that the tumour originates from the omentum and — judging from the appearance of its contents — is most probably a cystic degeneration of its lymph-spaces. The tumour is to a large extent adherent to the organs of the true pelvis. These adhesions having been loosened and ligatured, the uterus and its adnexa are exposed. The uterus proves to be of quite normal size and movable; it shows marks of the adhesions, but is otherwise without remark. The ramifications of the tumour have extended all round the adnexa of both sides, and especially on the left side there are still numerous cysts of the above-mentioned kind. The left adnexa are in other respects normal. The right oviduct is irregularly swollen and twisted; its ab-

dominal end is closed and attached to the ovary, on the surface of which there are a great many cysts resembling those mentioned above.

Salpingo-oophorectomy dextra.

The congeries of cysts having been detached from the pelvis, it is removed and the omentum is resected at the level of the navel. The tumour extends, however, as high as up to the spleen. As there are still masses of cysts everywhere in the parietal peritoneum (and as the tumour, seems to be com-

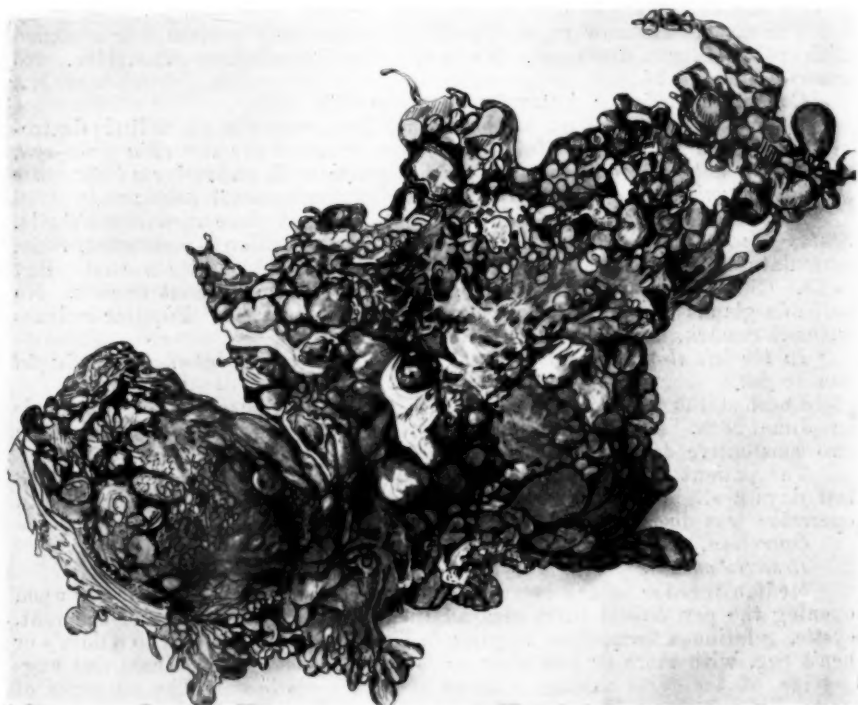


Fig. 3. Macroscopic picture (after photograph) of the tumour of Case No. II.

paratively benign), the cysts situated in the neighbourhood of the spleen are left behind. The removed tumour which is most suggestive of a cluster of very unequal grapes, is about the size of a fist. (Fig. 3.)

Abdominal suture.

Microscopic examination: (Professor FOLKE HENSCHEN. Chief of the Pathological Department of the Sabbatsberg Hospital). (Fig. 4.)

The specimen consists chiefly of large and small cystic spaces, between which a distinct connection can be proved only exceptionally. The size of the cysts varies within large bounds: besides the macroscopically visible cysts there are lots of microscopic ones of all sizes. In large parts of the

specimen there are chiefly big cysts, in others, a great many small ones of equal size. The shape of the cysts is, as a rule, spherical; small cysts lying close to the large ones are often flattened or irregular. Some of the smallest cysts are lengthened and somewhat resembling capillaries. As found on closer examination, these little lumina evidently arise from the excavation of solid germ cells (e. g. at the new formation of vessels out of angioblasts). The contents of the cysts consist of an easily stainable, loose, granular, fibrinous mass, evidently a coagulated serous fluid. Some few red blood

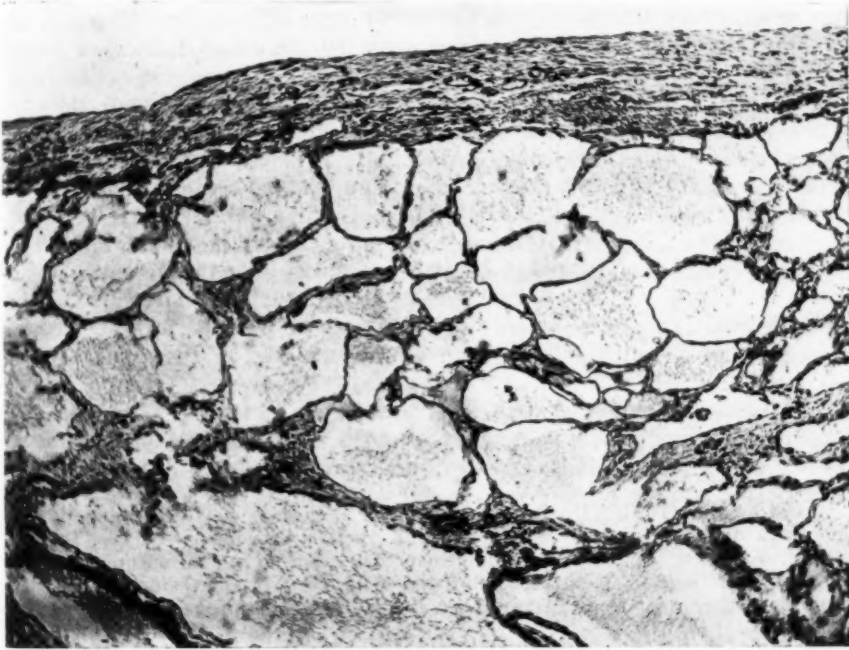


Fig. 4. Microscopic picture of the tumour of Case No. II.

corpuscles, or round cells with small nuclei, and comparatively large, light cell-bodies are seen scattered about in this mass. The walls of the cysts are lined with a single layer of endothelium, mostly membranous but sometimes cuboidal, with cells bulging into the lumen. Outside the layer of endothelium there is a more or less abundant quantity of connective tissue with loose, tortuous, collagen fibrils, blood-vessels of various dimensions, a very scanty elastic substance, and few nuclei. The stroma is often very little developed and almost devoid of vessels. The cysts lie then close together, separated only by the layers of endothelium and a very small reticulum. In other places the stroma forms coarse septa with well-developed blood-vessels, not unfrequently surrounded by round cell infiltrations. Here and there one sees

some small recent bleedings that have evidently occurred at the operation. Muscular tissue is nowhere to be seen.

Pathologic-histological diagnosis: *Lymphangioma cysticum*.

On account of the above-stated favourable experiences I proposed an after-treatment with Roentgen rays, which was given according to the following plan.

* * *

Treatment:

The Roentgen ray treatment was given by Dr. JAMES HEYMAN.

Filter each time = 0.5 mm Cu. + 1 mm Al.

Spark gap = 39 cm. M. A. = 2—2.5.

Skin doses = $\frac{1}{4}$ H. E. D.

Scheme of treatment:

Date	Field	Skin focus distance	Skin dose.
16/8	Abdomen, left	23 cm.	Estimated after the
22/8	" , right	" "	method of Voltz, the
24/8	" , left	" "	abdominal treatments
27/8	" , right	" "	give a result of about
30/8	" , left	" "	$\frac{1}{8}$ H. E. D. per dose;
31/8	Back	30 "	the treatments of the
1/9	Abdomen, right	23 "	back about $\frac{1}{20}$ H. E. D.
5/9	Back	30 "	per dose.
8/9	"	" "	

Oct. 23rd, 1923. During August and September 9 Roentgen treatments in all were given. Menses regular, their duration, 3—4 days, the interval, 4 weeks. No flux, no troubles on urination. Evacuation normal. No vomiting or nausea. *An occasional pain in the left side below the splenic region.* Otherwise free from pains (considerable improvement after the operation).

Status: Good general condition.

Abdomen: A soft, non-tender, elastic tumour about the size of a hen's egg is felt just below the spleen; the abdomen is normal in other respects.

Uterus anteфлекed, of normal size, movable; no swelling at the sides.

Healed by first intention.

No erosion, no flux.

After consultation with Dr. HEYMAN the patient was sent to Radium-hemmet for renewed Roentgen treatment of the tumour in the splenic region.

Treatment: Nov. 2nd. The deep effect (acc. to Voltz) is about $\frac{1}{8}$ — $\frac{1}{12}$ H. E. D.

Abdomen, left 23 cm. $\frac{1}{4}$ H. E. D.

Status on Jan. 29th 1924. The menstruation regular. At the last period, which ceased a week ago, there was an inconsiderable dysmenorrhea. On the day after the last examination she had a pain in the left side, but has since then been free from pains. She has not been treated since November.

Feeling quite well. *The tumour in the splenic region is no longer palpable.*
Uterus is as before.

Status on June 1st 1924. The patient is still well. Condition as before.

* * *

Both these cases seem to belong to the comparatively unknown group of omental cysts or, to put it more exactly, to the cavernous and cystic lymphangiomata. PRUTZ and MONNIER, who have the most exhaustive statistics of tumours of this kind, estimate the non-parasitic, mesenteric cysts known in 1913 at about 200, and the similar omented formations described at only 42, *16 of which were multilocular*. S. JOHANSON mentions 7 more cases. (STILLMAN's 3 cases, 1 of SCHRAMM, 1 of HOEPFL, and 2 multilocular omental cysts examined by himself). Tumours of this kind being thus very rare, a short representation of the opinions held by the authors as to them may be warranted.

Concerning the possibilities of the genesis of these tumours *three* theories have been advanced.

1) Slow dilatation of the lymph-trunks due to an obstruction to the efflux, with a new-formation of the elements of the vascular walls.

2) Active proliferation of the endothelium of lymph-vessels, with formation of solid masses of cells, between which cavities are formed that open into pre-existing lymph-vessels (homeoplastic neoplasia).

3) In produced granulation tissue new lymph spaces are formed by secondary transformation (heteroplastic neoplasia).

Most cases of omental cysts seem to belong to the early part of life: in 40 per cent of the cases published the patients are children under 10 years of age, and most of them belong to the female sex.

The cysts are partly unilocular and partly multilocular, though seldom of the latter kind. Their walls can be very different; the thickness may vary from membranous to about 7 mm. The wall generally consists of three layers: an outer one of white fibrous connective tissue with more or less strong bundles of muscles, a middle one containing dilated blood and lymph vessels and, lastly, an inner one which is most frequently lined with endothelial or epithelial cells. Sometimes a granulation tissue has been found all round the vessels. The contents of the cysts vary, being sometimes quite clear, sometimes darker, bloodstained or brown (on account of blood pigment). In one case the contents have been more gelatinous.

The clinical diagnosis — especially of the multilocular cysts — will be almost impossible. The differential diagnosis is made very

difficult by the fact that tumours of this kind are very rare, and have most frequently coalesced with other organs, and also by their resemblance to other abdominal tumours. It seems to me that the pointing out of a tumour situated close behind the abdominal wall and the absence of functional disturbances of the abdominal organs are the most important of the objective phenomena that can turn the thought in the right direction. — The fact may perhaps be of interest that the diagnose in several cases has been: ovarian tumour (as in my case No. II).

As to the prognosis in cases of cystic lymphangioma, our experience is naturally not very great. PRUTZ and MONNIER emphasize only that the prognosis in cases of omental tumour depends upon their anatomo-pathological structure. (Fibroma and lipoma give a better prognosis, though they may quite mechanically produce an injurious effect by their volume and weight.) The prognosis of cancer and sarcoma of the omentum is very poor; these tumours grow fast and they cause metastases at an early stage.

Of course, one cannot conclude from 2 cases how to act in a situation so exceptional as the one mentioned above. The prognosis of a disease of which only some twenty cases have hitherto been observed (I now mean only the *multiple* omental cysts), is naturally very little known. In the first case, an operation was *technically impracticable*, and in the second, too, a *radical removal* of the whole tumour with all its extended small cysts *would most probably have been impossible*. *In both cases the patient has been quite restored to health after the Roentgen treatment.* These tumours seem to have a relatively high degree of radiosensibility. They have disappeared after doses far below those required in cases of cancer of the uterus and corresponding more or less to the doses, that, according to experiences at the Radiumhemmet, often prove to be efficacious in cases of *ovarial cancer* that are inoperable or have been but incompletely operated. It is also of great interest that the healing seems to be permanent, as the first case has been observed for 4 years already. But one cannot, of course, be sure that a Roentgen treatment will always yield such a good result. *As the question of treatment stands now, however, I think one is justified in cases of this kind to cut away so much of the tumour as can be safely removed by a tolerably short operation and afterwards to employ Roentgen treatment.*

* * *

To all those who in some way or other have given me a helping hand in the preparation of this paper, I wish to offer my best thanks.

To the Professors E. AHLSTRÖM and G. FORSELL, Dr. PER CLARHOLM and Dr. J. HEYMAN, I am much indebted for their kindness in placing the material at my disposal. To the Professors WESTBERG and HENSCHEN and Dr. FORSELIUS I beg to offer my respectful thanks for the anatomo-pathological reports.

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SUMMARY

The writer gives an account of two cases of cystic, multilocular lymphangioma originating from the omentum. The first case is a 42-year-old man, the second, a 30-year-old woman. Both cases are operated upon, but in neither of them could a complete operation be accomplished. Both cases have been after-treated with Roentgen rays, and it has then been found that the Roentgen treatment has had an extraordinarily beneficial effect. In the first case, which has now been under observation for the past four years, taking of tissue for study was the only thing that could be done at the operation; in the second case which has been observed for one year, the main tumour was removed. Both cases are at present completely free from symptoms.

ZUSAMMENFASSUNG

Verf. berichtet über zwei Fälle von zystischem, multilokulärem Lymphangiom mit Ausgang vom Omentum. Es handelte sich um einen 42-jährigen

Mann und um eine 30-jährige Frau. Beide kamen zur Operation, aber bei keinem von beiden Fällen liess sich eine radikale Entfernung der Gebilde ausführen. Beide wurden mit Röntgenstrahlen nachbehandelt und es zeigte sich, dass die Bestrahlung eine ausserordentlich günstige Wirkung hatte. Im ersten Fall, der seither durch vier Jahre unter Beobachtung steht, hatte man bei der Operation nichts tun können, als Gewebsmaterial zu Untersuchungszwecken entnehmen; im zweiten Fall, der jetzt ein Jahr lang beobachtet ist, wurde der Hauptteil des Tumors entfernt. Beide Fälle sind jetzt völlig symptomfrei.

RÉSUMÉ

L'auteur rend compte de deux cas de lymphangiome vésiculaire et multiloculaire, provenant du grand épiploon. Le premier cas est un homme de 42 ans, le deuxième cas une femme de 30 ans. Tous les deux cas ont été opérés, mais dans aucun cas on n'a réussi de pratiquer l'extirpation complète. Tous les deux cas ont été traités ultérieurement par les rayons X. et ce traitement s'est montré d'un effet extraordinairement favorable. Dans le premier cas qui actuellement a été sous observation pendant les dernières quatre années, on ne pouvait à l'opération que prélever un fragment, en vue de l'examen histologique; dans le deuxième cas, qui maintenant a été sous observation pendant un an, la masse principale de la tumeur fut enlevée. Les deux cas sont maintenant complètement exempts de symptômes.

RESUMEN

El autor presenta dos casos de limfangioma vesicular y multilocular, ocasionados por el gran epiplón. El primer caso es de un hombre de 40 años y el segundo de una mujer de 30 años. Ambos casos fueron operados, pero en ninguno de los dos se logró la extirpación completa. Ambos casos fueron tratados posteriormente por los rayos X y este tratamiento ha demostrado unos efectos extraordinariamente favorables. En el primer caso que ha estado en observación durante los últimos cuatro años, en el momento de la operación no puedo extirparse más que un fragmento, en vista del examen histológico; en el segundo caso, que hasta ahora ha estado en observación durante un año, la masa principal del tumor fué extraída. Ambos casos están actualmente completamente exentos de síntomas.